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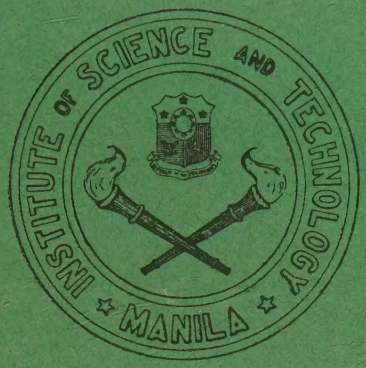

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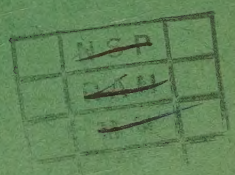

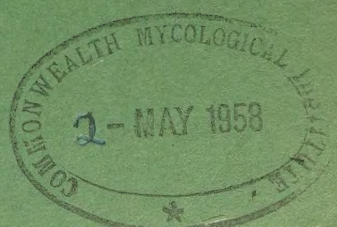

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THE PHILIPPINE
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RESIDENT BIRDS OF POLILLO ISLAND

BY CANUTO G. MANUEL
National Museum, Manila

ONE PLATE

McGregor[1] gave an account of the birds his party collected in the island of Polillo about 48 years ago. Fascinated by the results of studies made by those who had the privilege of examining the birds in the collection of the museum before it was completely destroyed during the war in 1945, the writer included Polillo among the priority list of islands to be visited for further collecting should opportunity arise. Accordingly, in November and December, 1948, Messrs. A. P. Castro and P. Añonuevo were sent to Polillo Island where they spent 28 days collecting birds in the vicinity of Burdeos, including the district of Anibawan and the adjacent Karlagan Island. In April, 1956, the writer accompanied by Messrs. Fernando G. Dayrit and Jacinto Ramos made a collecting trip to Anibawan and its vicinity. Mr. Dayrit devoted his time to collecting land and marine shells, while Mr. Ramos and the writer collected birds.

Polillo Island, the largest in the group is in the Pacific Ocean lying between latitudes 14° 40′ N and 15° 10′ N and longitudes 121° 10′ E and 122° 10′ E. It is separated from the eastern coast of Central Luzon by Polillo Strait, the deepest portion of which is about 200 fathoms. The distance between the nearest points in the two islands is about 16 air miles (25.6 kms.).[2]

[1] McGregor, R. C. Birds collected in the Island of Polillo, Philippines. Philip. Jour. Sci. § D 5 (1910) 103–114.

[2] U. S. Army. Southwest Pacific Area. Allied geographical section. Terrain Studies No. 91, Tayabas Province (1944) 32.

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The island has a general direction of north-south with a length of about 46.4 kms.; its width varies from 9.6 kms. to about 24 kms. Much of the coast is fringed with mangroves, coral reefs and sand beach, certain areas of which are white. An undulating ridge along the middle is a prominent feature of the island, the highest point being Mt. Malulo with an elevation of about 325 meters. In many places, particularly in the southern part, coconut groves and intermittent rice paddies are prominent features of plant association.

It may be observed that collecting in later years was confined in the neighborhood of Anibawan, in the northeastern end of the island (Plate 1). This is largely due to the fact that this part of the island still has patches of virgin and second-growth forests compared to an almost entirely cultivated area in other places particularly the southeastern part.

In carrying out his 1956 collecting trip the writer was partly aided by the American Museum of Natural History in New York City. He was also the recipient of the kindness of Mr. Ray Lehman of Manila, a fishing concessioner in Anibawan, who extended to him the facilities of his concession. Without these generous supports, the writer would have encountered much difficulty in carrying out his plan of collecting birds in Polillo Island.

NOTEWORTHY BIRDS OF POLILLO ISLAND

ENDEMIC BIRDS

In 1909, when McGregor's party spent about two months in the island, a total of 67 resident forms was recorded. It is interesting to note that to this day, ten new subspecies have been described from those originally reported by McGregor. Six of them were described before they were destroyed in 1945. Their destruction caused the naming of neotypes[3] from among the birds collected by Castro and Añonuevo in 1948. The following are ten endemic forms thus far described from the island of Polillo: *Accipiter virgatus castroi* Manuel and Gilliard, *Phapitreron amethystina polillensis* Hachisuka, *Tanygnathus sumatranus freeri* McGregor, *Tanygnathus lucionensis hybridus* Salomonsen, *Cacatua haematuropygia mcgregori* (Hachisuka),

[3] Manuel, C. G. Neotypes of some Philippine birds. Philip. Jour. Sci. 85 (1956) 315–321.

Centropus unirufus polillensis Hachisuka, *Penelopides panini subnigra* McGregor, *Chrysocolaptes lucidus grandis* Hachisuka, *Copsychus luzoniensis parvimaculata* (McGregor), and *Cynniris sperata manueli* Salomonsen. In addition, three other birds originally reported by McGregor are described as new subspecies in this paper.

HARPACTES ARDENS MINOR subsp. nov.

Type.—Philippine National Museum No. 0–5256, adult ♂; Anibawan, Polillo Island, April 12, 1956; C. G. Manuel and J. Ramos, collectors.

Diagnosis.—Differs from other forms of *Harpactes ardens* in being smaller and in having the red color of the breast, belly and undertail coverts much more intense, the breast almost brick red.

Measurements.—Type: wing, 136 mm; tail, 175, culmen from base 17.

OTHER MATERIALS

Cat. No.	Sex	Locality	Wing	Tail	Culmen from nostril
2608	♀	Polillo	138	176	16
2609	♀	Polillo	136	177	16
2610	♀	Polillo	135	177	16
5257	♂	Polillo	136	175	18
2078	♀	Samar	144	183	18
2080	♀	Samar	145	187	18
508	♀	Mindanao	142	193	17
510	♀	Mindanao	142	198	17
513	♀	Mindanao	143	192	17
1336	♂	Mindanao	142	198	19
1976	♂	Mindanao	141	200	19
2024	♂	Mindanao	143	200	19
140	♀	Luzon (Abra)	139	188	16
2938	♀	Luzon (Bataan)	146	190	15

Range.—Polillo Island. It is believed this form inhabits also the other forested islands of the Polillo group like Jomalig, Palasan, and Patnanongan in which no collecting has yet been made.

Remarks.—Rand and Rabor[4] made a study of materials at their disposal and arrived at the conclusion that the Luzon form is distinct from the nominate subspecies. They described the new form as H. a. *luzoniensis*. Four females from Samar were examined by the writer and although the measurements of the

[4] Rand, A. L., and D. S. Rabor. Two new birds from Philippine Islands. Nat. Hist. Misc., No. 100 (1952) 1–3.

wing, tail, and culmen are intermediate between *H. a. ardens* and *H. a. luzoniensis*, the description of a new subspecies from Samar is held in abeyance pending availability of male specimens from that island.

This subspecies is peculiar among endemic birds of Polillo Island in that while others are generally larger than their nearest ally from Luzon, this is smaller.

MULLERIPICUS FUNEBRIS PARKESI subsp. nov.

Type.—Philippine National Museum No. 0–2638, adult ♂; Anibawan, Polillo Island, December 9, 1948, A. P. Castro and P. Añonuevo, collectors.

Diagnosis.—Differs from *M. f. funebris* which it closely resembles in having the crimson patch of face darker in intensity; on head the red patch covers a narrower area, almost confined to forehead; bill longer, the greater basal part of upper mandible, black.

Measurements.—Type; wing, 165 mm; tail, 137; bill from nostril, 34.

OTHER MATERIALS

Cat. No.	Sex	Locality	Wing	Tail	Bill from nostril
2637	♂	Polillo Is.	164	133	32
2638	♂	Polillo Is.	165	136	33
2636	♀	Polillo Is.	164	140	31
187	♂	Luzon (Abra)	165	141	29
188	♂	Luzon (Abra)	161	133	30
184	♀	Luzon (Abra)	160	140	30
185	♀	Luzon (Abra)	166	143	30
2991	♂	Luzon (Bataan)	154	135	31

Range.—Polillo Island.

Remarks.—This is named for Dr. Kenneth C. Parkes of Carnegie Museum, Pittsburg, Pennsylvania, U.S.A., who, while visiting Manila in August through October, 1956, confirmed the distinction of this new form.

TERPSIPHONE UNIRUFA RAMOSI subsp. nov.

Type.—Philippine National Museum No. 0–5432, adult ♂; Anibawan, Polillo Island, April 20, 1956; C. G. Manuel and J. Ramos, collectors.

Diagnosis.—Differs from *T. u. unirufa* of Luzon which it closely resembles in having the chestnut rufus more intense, the wings and tail longer and the bill at gape narrower. From

the lone specimen collected at Tablas Island, it differs in being smaller and the gape at base of bill much narrower.

Measurements.—Type: wing, 94 mm; tail, 109 (short); 178 (long); bill from nostril, 15; width at gape, 11.

OTHER MATERIALS

Cat. No.	Sex	Locality	Wing	Tail		Bill from nostril
				Short	Long	
2706	♂	Polillo Is.	94	99	138	15
2708	♂	Polillo Is.	87	100		16
2711	♂	Polillo Is.	94	101	164	16
2707	♀	Polillo Is.	84	94		15
2709	♀	Polillo Is.	88	100		16
2710	♀	Polillo Is.	83	93		15
5788	?	Luzon (Manila)	87	100		16
4858	♂	Tablas Is.	98	110		17
1298	♀	Mindoro Is.	82	88		14
1299	♀	Mindoro Is.	84	95		15

Range.—Polillo Island.

Remarks.—This is named for Mr. Jacinto Ramos of the National Museum in Manila who has shown keen interest and promise in collecting natural history specimens. The lone specimen from Tablas Island presents features of novelty but insufficiency of material compels the writer to hold the matter of describing it as a new subspecies in abeyance.

ADDITIONAL RESIDENT BIRDS

Castro and Añonuevo in 1948 collected 40 out of 67 resident forms reported by McGregor. In addition they obtained black-chinned fruit dove and short-crested blue monarch hitherto unreported from that island.

Black-chinned fruit dove (*Ptilinopus leclancheri leclancheri*). A female was recorded. This dove inhabits the tree tops of rain forest in many islands from Luzon to Mindanao. It generally goes in pair and with its gray and green underparts, it is difficult to observe its presence in the thick foliage of its perch. However, this and other fruit pigeons sometimes visit certain species of trees at the edge of the primary forest when the trees are in fruitage. Here the presence of this dove is detected easier. Apparently its close allies are *P. l. longialis* of the Batanes and possibly of the Babuyanes groups and *P. l. gironieri* of Palawan and the Calamianes groups of islands. In 1956, Manuel and Ramos collected 4 males and 2 females of this fruit dove in Polillo Island.

Short-crested blue monarch (*Hypothymis helenæ helenæ*). Two males and 2 females were collected by Castro and Añonuevo in 1948. In 1956 Manuel and Ramos obtained 2 males and one female. They are identical with the only male specimen from Samar available for comparison. It should be observed that this form has not been reported in the intervening islands of Luzon and Catanduanes. The habits are, in many respects, similar to black-naped blue monarch (*Hypothymis azurea azurea*) and until after very close examination one may be mistaken for the other.

In 1956, Manuel and Ramos collected a total of 57 resident forms, including 51 previously reported by McGregor,(2) two were collected for the first time by Castro and Añonuevo in 1948 and four are new records. The new records are bushhen, watercock, hawk-cuckoo, and koel.

Bushhen (*Amaurornis olivaceus olivaceus*). A male was collected. This bird has been observed at some distance away from water although in other places, the nest is invariably always found on or near the water. The bird was observed on a branch of a tree about two meters from the ground.

Watercock (*Gallicrex cinerea*). A male was recorded. The bird makes a loud call note at early morning and in the evening when there is generally an exchange of call between the cock and the hen. Undergrowth of thick rice stalks is its favorite haunt but its skill as skulker challenges a keen observer. The observation that watercock migrates locally at certain seasons of the year needs confirmation.

Hawk cuckoo (*Cuculus sparverioides sparverioides*). A male was recorded. The hawk cuckoo is a rare bird wherever it occurs in the Philippines. This peculiarity, coupled with the fact that its breeding habits, its nest and eggs have not been observed makes one suspect strongly that the bird may be a rare straggler. Our bird was taken April 19, which may not be too late for some transients. Further collecting should establish its status, although it is generally admitted as a resident form.

Koel (*Eudynamis scolopacea mindanensis*). Two males were collected on a defoliated branch of a tree on second growth. It was rather unusual for this bird to be exposed calling at about 10:00 o'clock in the morning, as it is known to frequent thick foliage of primary and second growth. Its call notes are generally uttered in the evenings and mostly during the breeding

season. There is indication to believe that females were in the nest at the time of collecting.

RESIDENT BIRDS RECORDED FROM POLILLO ISLAND

A consolidation of the birds collected in Polillo Island shows a total of 73 resident forms (species and subspecies) recorded so far. They are listed below.

[Those in boldface are endemic.]

1. *Egretta sacra*
2. *Egretta garzetta nigripes*
3. *Nycticorax caledonicus manillensis*
4. *Bubulcus ibis coromandus*
5. *Butorides striatus carcinophilus*
6. *Ciconia episcopus episcopus*
7. *Anas poecilorhyncha luzonica*
8. **Accipiter trivirgatus castroi**
9. *Spilornis cheela holospilus*
10. *Haliastur indus intermedius*
11. *Megapodius freycinet pusillus*
12. *Gallus gallus*
13. *Rallus torquatus torquatus*
14. *Amaurornis olivaceus olivaceus*
15. *Gallicrex cinerea*
16. *Esacus magnirostris*
17. *Treron pompadora axillaris*
18. **Phapitreron amethystina polillensis**
19. *Ptilinopus marchei marchei*
20. *Ptilinopus leclancheri leclancheri*
21. *Macropygia phasianella tenuirostris*
22. *Ducula aenea chalybura*
23. *Ducula bicolor bicolor*
24. *Streptopelia bitorquata dusumieri*
25. *Chalcophaps indica indica*
26. *Gallicolumba luzonica luzonica*
27. **Cacatua haematuropygia mcgregori**
28. **Tanygnathus lucionensis hybridus**
29. **Tanygnathus sumatranus freeri**
30. *Loriculus philippensis philippensis*
31. *Phoenicophaeus superciliosus*
32. **Centropus unirufus polillensis**
33. *Centropus viridis viridis*
34. *Cuculus sparverioides sparverioides*
35. *Eudynamis scolopacea mindanensis*
36. *Ninox philippensis philippensis*
37. **Harpactes ardens minor**
38. *Halcyon chloris collaris*
39. *Halcyon smyrnensis gularis*
40. *Pelargopsis capensis smithi*
41. *Alcedo atthis bengalensis*

[Those in boldface are endemic.]

42. *Ceyx cyanopectus cyanopectus*
43. *Ceyx melanurus melanurus*
44. *Eurystomus orientalis orientalis*
45. **Penelopides panini subnigra**
46. **Chrysocolaptes lucidus grandis**
47. **Mulleripicus funebris parkesi**
48. *Anthus novaseelandiae lugubris*
49. *Coracina striata striata*
50. *Lalage nigra chilensis*
51. *Collocalia esculenta marginata*
52. *Cypsiurus parvus pallidior*
53. *Artamus leucorhynchus leucorhynchus*
54. *Irena cyanogaster cyanogaster*
55. *Pycnonotus urostictus urostictus*
56. *Microscelis gularis gularis*
57. **Copsychus luzoniensis parvimaculata**
58. *Rhipidura javanica nigritorquis*
59. *Niltava rufigaster simplex*
60. *Hypothymis azurea azurea*
61. *Hypothymis helenæ helenæ*
62. **Terpsiphone unirufa ramosi**
63. *Dicaeum pygmaeum pygmaeum*
64. *Dicaeum trigonostigma xanthopygium*
65. **Cynniris sperata manueli**
66. *Cynniris jugularis jugularis*
67. *Aethopyga shelleyi flavipectus*
68. *Sarcops calvus calvus*
69. *Lonchura leucogaster everetti*
70. *Lonchura ferruginosa jagori*
71. *Dicrurus balicassius balicassius*
72. *Oriolus chinensis chinensis*
73. *Corvus macrorhynchus philippinus*

NOTES ON EVOLUTIONARY TRENDS

The foregoing list of birds recorded in Polillo Island includes 73 supposedly resident forms. In this connection, further study is necessary to determine whether all these forms, particularly reef egret (*Egretta sacra*), cattle egret (*Bubulcus ibis coromandus*), little mangrove heron (*Butorides striatus carcinophilus*), braminy kite (*Haliastur indus intermedius*), reef thick-knee (*Esacus magnirostris*), watercock (*Gallicrex cinerea*), and hawk cuckoo (*Cuculus sparverioides sparverioides*) breed in this island.

This study shows that the island of Polillo derived its bird fauna from the adjacent mainland of Luzon. It does not have either a genus or a species endemic to the island so far as this study shows, suggesting that colonization of the island took

place in not too distant past. Of 73 resident species recorded, 47 are non-passerine, while 26 are passerine species. Of the 73 species, 13 subspecies (19 per cent) are endemic, of which 10 (21 per cent) are non-passerine, while 3 (11.5 per cent) are passerine subspecies.

The noteworthy differences between the endemic forms of Polillo Island and their close relatives from the adjacent mainland of Luzon, from which the bird fauna of the former island must have been derived are: size, length of bill or color intensity. This study shows that so far, except in the case of *Harpactes ardens minor*, the endemic forms of Polillo are larger than their closest allies in the island of Luzon. There is, likewise, a trend for the bill to be longer in the endemic birds of Polillo. Moreover, Polillo forms have a tendency to be brighter in color.

Further collecting in this and other islands of the group will doubtless yield more interesting results. Jomalig, Palasan and Patnanongan Islands should particularly be visited for bird collecting. Minasawa Island is locally called "Bird Island" because it is claimed to be a haven for certain forms of fruit pigeon that congregate there at certain seasons of the year.

SUMMARY

The resident birds of Polillo Island, tentatively numbering 73 forms, are discussed in this paper.

Polillo Island is the largest in the group that lies east of Central Luzon in the Pacific Ocean. The nearest point to the mainland of Luzon is about 25.6 kilometers.

Including three that are described in this paper, a total of 13 subspecies (19 per cent) have been recorded so far, as endemic to Polillo Island. These include 10 out of 47 (21 per cent) non-passerine, and 3 out of 26 (11.5 per cent) passerine subspecies. This study shows that the bird fauna of Polillo Island is an extension of that of Central Luzon from which the former must have had a direct connection in a not too distant past. Endemic forms of Polillo Island show trends to become larger, to possess longer bill or to have brighter color than their nearest allies in Luzon.

Further bird collecting in Polillo and other islands of the group is suggested, as it is believed that this will yield interesting results.

ILLUSTRATION

PLATE 1

Polillo and adjacent islands off the eastern coast of Luzon.

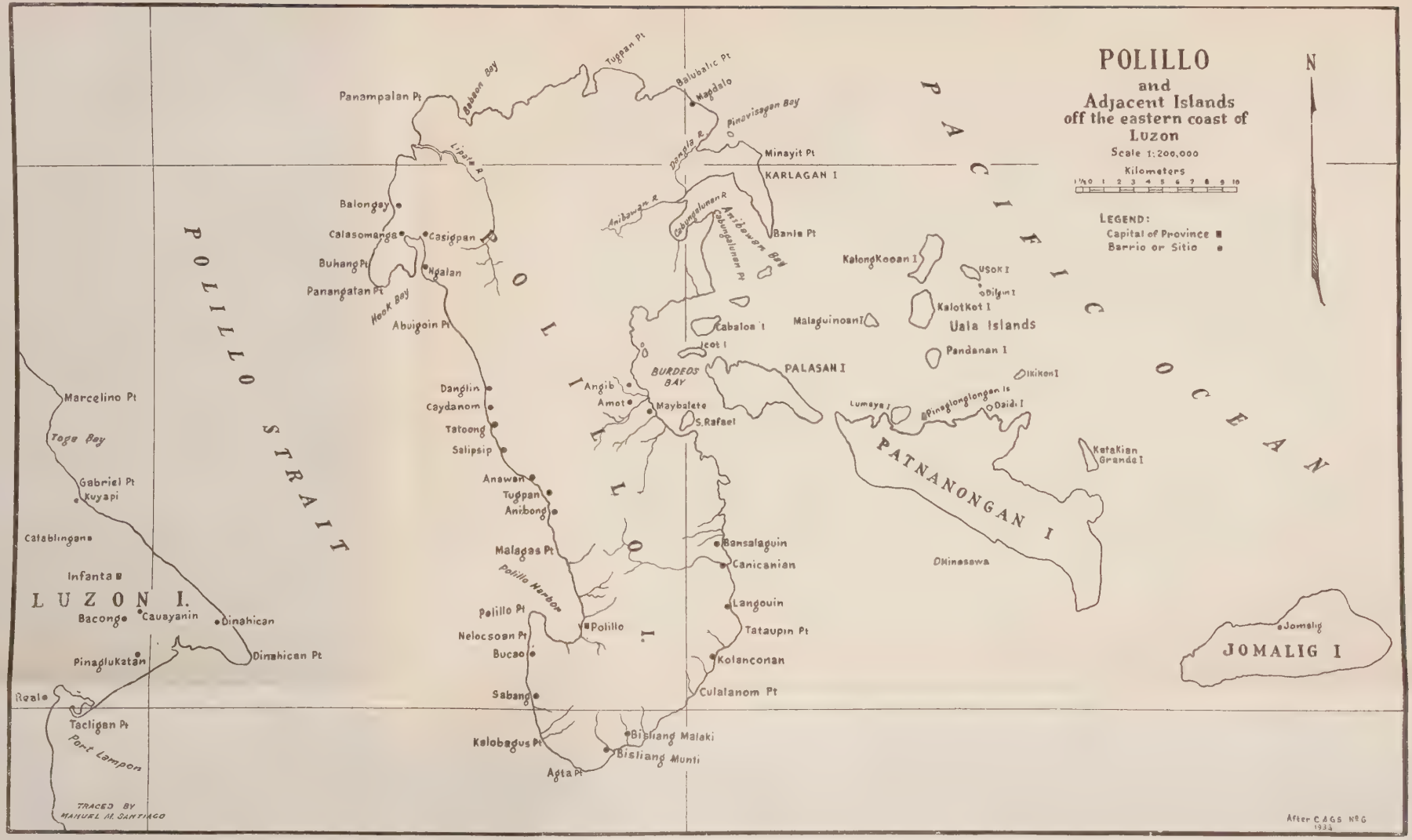
POLILLO
and
Adjacent Islands
off the eastern coast of
Luzon
Scale 1:200,000
Kilometers
LEGEND:
Capital of Province
Barrio or Sitio
N
PACIFIC OCEAN
POLILLO STRAIT
POLILLO I.
LUZON I.
PATNANONGAN I
JOMALIG I
Uala Islands
PALASAN I
KARLAGAN I
Panampalan Pt
Babson Bay
Tuppan Pt
Balubalic Pt
Magdalo
Pinaviscgan Bay
Minayit Pt
Banla Pt
Balongay
Calasomanga
Casigpan
Buhang Pt
Ngalan
Panangatan Pt
Hook Bay
Abuigoin Pt
Anibawan Bay
Cabungalunan Pt
KalongKoan I
USOK I
Bilgun I
KalotKot I
Malaguinoan I
Cabaloa I
Icot I
Pandanan I
IKikon I
Lumaya I
Pinaglonglongan Is
Ozias I
Ketakian Grande I
Marcelino Pt
Toga Bay
Gabriel Pt
Kuyapi
Catablingan
Infanta
Baconge
Causyanin
Dinahican
Dinahican Pt
Pinaglukatan
Real
Tacligan Pt
Port Lampon
TRACED BY MANUEL M. SANTIAGO
Danglin
Caydanom
Tatoong
Salipsip
Anawan
Tuppan
Anibong
Malagas Pt
Polillo Harbor
Polillo Pt
Nelocsoan Pt
Bucao
Sabang
Kalobagus Pt
Agta Pt
Bisliang Malaki
Bisliang Munti
Angib
Amot
Maybalete
S. Rafael
BURDEOS BAY
Bansalaguin
Canicanian
Langouin
Tataupin Pt
Kolanconan
Culalanom Pt
Minasawa
Jomalig
After C.A.G.S. M.S. 1933

PLATE 1.

NEW RECORDS OF PHILIPPINE AND OTHER TROPICAL PACIFIC LICHENS WITH DESCRIPTIONS OF FIVE NEW SPECIES

By Albert W. C. T. Herre
University of Washington

The lichen flora of the Philippines is as yet imperfectly known. Many of those described by Vainio and others, including myself, are known from but a single locality. This is sufficient proof that they have been but little collected. Any intensive collecting in the Philippines is sure to reveal lichens new to the Islands and perhaps new to science. It is certain to extend our knowledge of lichen distribution.

The lichen collector must avoid the rice fields as well as those of abaca, bananas, kamotes, kamoting kahoy, pineapple, sisal, and tobacco, and look about him almost anywhere else. From Y'Ami to Sitankai trees and shrubs from seashore and mangrove swamp to the top of the highest mountains, rocks and cliffs, leaves and bark, valleys, mountains, and plateaus are all ready to yield their treasures to the keen-eyed.

My trips all over the Islands, from Aparri to Balabac, Sitankai, and Davao, gave me many lichens during the years from 1920 to 1948. Various friends also secured lichens for me, especially Dr. E. H. Taylor, the distinguished herpetologist, at Baguio and Tablas. Mrs. Mary Strong Clemens also collected lichens in Mindanao and at Baguio.

My largest collections of lichens were made in the vicinity of Dumaguete and the adjacent mountains, during many visits there between 1920 and 1948. Most of my Negros lichens came from the vicinity of the mountain cottage of my dear friend Dr. James W. Chapman, for many years head of the science department of Silliman University. This cottage and grounds, known as Camp Lookout, is at an altitude of 500 meters. It is located above the little town of Luzuriaga, on the eastward face of the group of volcanos known as Los Cuernos de Negros. Here one is near the upper limit of the coconut and abaca plantations and is surrounded by a great variety of trees in the immediate vicinity and has access to the great jungle on the higher elevations, and to a wealth of lichen encrusted rocks in the great gorges that seam the mountain sides.

To save needless repetition, lichens from this region are simply listed as from Camp Lookout, omitting altitude and further geographical location, unless from more than 700 meters altitude.

In addition to the Philippine lichens given here, a number of others are included which I collected at various places in the tropical Pacific. They range from the Malay Peninsula to the Pelew, Society, and Marquesas Islands. They are noted here because of the extension of their known range.

The types of the new species described are in the Herre Lichen Herbarium.

Genus PHÆOGRAPHINA § PACHYLOMA

PHÆOGRAPHINA NEGROSENSIS Herre, sp. nov.

Thalus tenuis, fulvus, laevigatus, K—. Apothecia sparsa aut sat approximatus, vulgo elongatus usque 17.5 mm longa, 0.3 ad 1. mm lata, saepe flexuosa curvatava, simplicia aut rarius parce ramosa, bene elevata, apicibus obtusus. Discus primum rimaeformis, demum dilatatus, rubidus sed cinereo-pruinosus, excipulum integrum, fuligineum, labiis integris, erectis vel divergentibus; hymenium rubidum. Sporæ solitariæ, 31–40 μ latæ et 108–145 μ longæ.

Ad corticem arboris, Camp Lookout; alt. circa 600 meters.

Thallus thin, smooth, yellowish, K—. Apothecia far apart or now approximate, commonly elongate, up to 17.5 mm, with a width of 0.3 to 1 mm; often sinuously curved, simple or infrequently branched, well elevated with obtuse ends. The disk is very narrow at first, later becoming dilated, red but usually heavily ashy pruinose; exceipulum entire, black; hymenium red. Spores solitary, 31 to 40 μ broad by 108 to 145 μ long.

Growing on the bark of trees at camp Lookout at an altitude of about 600 meters; specimens scanty. This species is very distinct from other species of this section of Phæographina previously reported from the Philippines. The red apothecial disk strongly separates it from other East Indian species of the section *Pachyloma*.

HELMINTHOCARPON TAYLORI Herre, sp. nov.

Thallus tenuis, uniformis, cinereus, laevigatus, plus minus fuscus cum K; linea hypothallino nigricante limitatus. Apothecia sparsa, simplicia, apicis rotundatis, 0.6 ad 2.5 mm longæ, 0.2 and 0.6 mm latæ, margine crassus thallino erecto; disco plano nigro, excipulum dimidiatum, infra hymenium late deficiens, labiis erectis, nigrum, integris, margine thallino obductis.

Hymenium pallido-luteus; paraphyses tenuissimæ, ramosæ et intricatæ, ceterum simplices cum K. Sporæ octonæ, interdum binæ, quaternæ, et senariæ, 7–12 μ latæ et 27–44 μ longæ; loculis subcubicus, in seriebus horizontalis plerumque 9, verticalibus 3; cum jodo violaceus.

Ad corticem arbores, Insula Tablas.

Thallus thin, uniform, smooth, ashen in color; more or less brownish with K; limited by a black hypothalline line.

Apothecia scattered, simple, their tips rounded, 0.2 to 0.6 mm broad and 0.6 to 2.5 mm long; the thick erect margin is covered by the thallus; the disk is flat and black. The dimidiate excipulum is widely deficient beneath, with entire erect black lips. Hymenium very pale yellow; paraphyses very slender, intricately branched, but some are simple in a K solution. Spores 8, but also sometimes 2, 4, or 6, more or less cylindraceous-oblong, one tip always rounded but the other often pointed, 7 to 12 μ broad and 27 to 44 μ long; usually with 9 rows of locules transversely and 3 rows longitudinally; violet with I.

On the bark of a tree, Tablas Island; specimens scanty.

Very distinct from the only other species previously recorded from the Philippines, *Helminthocarpon pervarians* (Nyl.) Vain. var. *McGregori* Vain., which has solitary spores, 9.2 to 14 μ by 21 to 70 μ. It is also quite different from the only recorded East Indian species, *Helminthocarpon prevosti* Fée, which has 8 spores measuring 20 to 36 μ in breadth by 90 to 150 μ in length.

I have no doubt that careful search of tree trunks along the shores of the central Bisayan Islands would find this to be relatively common. I take pleasure in naming it after Dr. Edward H. Taylor, who spent many years in exploring the Philippines and became our chief authority on the snakes, lizards, frogs, turtles, and mammals of the Islands.

LECIDEA VISAYANA Herre, sp. nov.

Thallus tenuis, continuis, lævigatus aut leviter rimosus, pallidissima cervinus, K + luteus demum fuscus aut fusco-rufus; hypothallus nigricante.

Apothecia crebra, primum innata deinde adnata, minuta usque 0.9 mm lata, rotunda deinde leviter difformis, margine crasso, elevato, persistente; disco plano, nudo, badio-rufus, madefacto rufus clarus; epithecium 9–12 μ crassum, granulosum,

luteo-fuscescens; thecium 40–45 μ crassum, hyalinum, jodo caerulescens; hypothecium 30 μ crassum, pallido-lutescens; paraphyses 0.75–1 μ crassis; sporæ 3.5–4.5 μ latæ, 8–9.3 μ longæ.

In saxa volcanica propte Camp Lookout.

Thallus thin, smooth, uniform or minutely rimose, very pale tan; K + yellow, then brown or brownish red; a limiting black hypothallus.

Apothecia abundant, at first innate but soon adnate, mostly minute to small, reaching a diameter of 0.9 mm, circular to somewhat irregular, the thick margin concolorous, elevated, persistent; disk plane, naked, dull red brown, becoming clear brown red when wet. Epithecium 9 to 12 μ thick, granulose, yellowish brown; thecium 40 to 45 μ thick, hyaline in thin section but pale yellow when thick, blue with I; hypothecium 30 μ thick, pale yellow but yellowish brown in thick sections. Spores 3.5 to 4.6 μ broad, 8 to 9.3 μ long.

Growing on huge boulders of volcanic rock near Camp Lookout, in the gulch from which Luzuriaga, Negros Oriental Province gets its water supply; altitude about 500 meters. A conspicuous lichen but difficult to get. Another specimen probably of the same species was collected from a boulder in the same gorge at altitude of 800 meters. Apothecia not well developed, yielding no spores. Determination not positive therefore.

BACIDIA HOWARDI Herre, sp. nov.

Thallus tenuis, continuus, effusus, glauco-albidus aut glaucus, hypothallo nullus, K—.

Apothecia sat dispersa, biatorina, rotunda, adnata, plana, nuda, parvus aut minutus plerumque plus minus 0.3–0.5 mm lata sed 0.9 mm attingens; disco rufo aut obscuro rufo interdum fuscescente, margine plerumque persistente, plus minus obscuratio; thecium plus minus hyalinum, I—, 60–70 μ crassum; paraphyses aseptata, simplices, filiformes ad apicem non llatiores, 0.3–0.5 μ crassus; asci oblongo-clavati superne rotundati; 8 spori; 9–13 μ latæ et 55–65 μ longæ; hypothecium dilutium luteolum fere pallidum, circo 60–65 crassum, I rufo-fuscum; sporæ in ascis plus minus biseriales, decolores, 4–6 locuares, 4.5–6.5 μ latæ et 12.5–18.6 μ longæ.

Ad saxa granitica, supra Luzuriaga, Los Cuernos de Negros, alt. circa 800 meters.

Thallus thin, effuse, continuous, greenish white to greenish, K—. Apothecia scattered, not abundant, biatorine, plane, naked,

adnate, small to minute, mostly 0.3 to 0.5 mm in diameter but reaching 0.9 mm in width. The disk is red or dark red, sometimes fuscus, the margin usually persistent, more or less darkening. Thecium hyaline or nearly so, I—, 60 to 70 μ thick; paraphyses simple, not septate, threadlike, their tips not widened, free at least in K, 0.3 to 0.5 μ thick; asci oblong clavate their tips rounded, with 8 spores, 9 to 13 μ wide and 55 to 65 μ long, yellowish with I; hypothecium pale yellowish, nearly pellucid, about 60 to 65 μ thick, dark red or yellowish red with I; spores usually in two rows in the asci, colorless, 4 to 6 locular, 4.5 to 6.5 μ wide and 12.5 to 18.6 μ long.

An obscure lichen, the sole specimen largely hidden from view by a liverwort growing over it. Specimen collected from a granite boulder at the bottom of a gorge at an altitude of 800 meters above Luzuriaga on the side of Los Cuernos de Negros. Specimen very difficult to obtain.

Named for Dr. Grace E. Howard, devoted student of lichens and author of the useful volume entitled "Lichens of the State of Washington."

BUELLIA TABLASENSIS Herre, sp. nov.

Thallus crustaceus, uniformis, tenuis, plus minus rimosus, maculas formans circa 60 ad 70 mm latas, sorediis et isidiis destitutus, cinereo-albidus, cum K pulchræ rubicundus; C—.

Apothecia creberrima, orbiculata, ad flexuosa et deformans, nigra, opaca, 0.25 ad 1.5 mm lata; disco plano, caesio-pruinoso; margine nigro, integro et interdum flexuoso; hymenium circa 80–80 μ crassum, luteo pallidissimum aut quasi hyalinum; jodo persistenter cærulescens; hypothecium fuscus, circa 100—120 μ crassum; sporæ octonæ, distichæ, uniseptatæ, fuscus, oblongæ aut ellipsoidæ-oblongæ, 4–6.4 μ lat., 10.8–15 μ long.

Legit January 20, 1923, ad truncos *Cocos nucifera* propte Odiongan, Insula Tablas.

Thallus thin, uniform, more or less minutely rimose, forming ashy white spots 60 to 70 mm in diameter, becoming beautiful dark red with K. Apothecia very abundant, circular, becoming flexuous and irregular or deformed, black, reaching 1.5 mm in diameter but mostly 0.5 to 1 mm; disk flat, caesious pruinose; the black and slightly elevated margin may become flexuous and irregular; hymenium 80 to 90 μ high, very pale yellow to nearly colorless, permanently blue with I; hypothecium very dark brown, about 100 to 120 μ thick; spores brown, 8, in 2 rows

in asci, oblong to ellipsoid-oblong, 4 to 6.4 μ wide and 10.8 to 15 μ long.

Growing on the trunk of *Cocos nucifera* near Odiongan, Tablas. Only the type specimen was secured. No doubt this lichen is found along the seashore throughout the Bisayas.

ACAROSPORÆ ASAHINÆ Magnusson.

On rock beside the trail between Banguad and Lubuagan, Kalinga subprovince, Luzon; altitude about 900 meters. Specimen determined by Dr. A. H. Magnusson. A Japanese lichen; new to the Philippines.

ANAPTYCHIA HYPOLEUCA (Mühlenb.) Mass.

Baguio, Mountain Province, at 1,600 meters, growing on rocks. Above Banaue, Ifugao Subprovince, at 1,150 meters, growing on the base of a tree. Above Luzuriaga, Negros Oriental Province, at 800 meters.

ANAPTYCHIA HYPOLEUCA var. FULVESCENS Vainio.

Above Banaue, Ifugao Subprovince, at 1,150 meters. Previously known from Benguet, Mountain Province, at 1,500 meters.

ANAPTYCHIA HYPOLEUCA var. SOREDIIFERA (Müll. Arg.) Vainio.

On rocks above Luzuriaga, Negros Oriental Province, at 800 meters. Previously known from Bauco, Bontok Subprovince, at 1,300 meters. Originally reported from the West Indies.

ANAPTYCHIA ISIDIOPHORA (Nyl.) Vainio.

Near the School of Forestry, Laguna Province, altitude 200 meters. The Ilokano name of this lichen is *Pak'ak*. Previously reported from Benguet Subprovince, Luzon. Known from the West Indies, and tropical Africa.

ANAPTYCHIA LEUCOMELÆNA (L.) Vainio.

Between Banaue and Bontok, Mountain Province, growing among mosses at 1,200 meters. Widely distributed in the mountains of Luzon and Mindanao from 300 meters upward. Of world-wide distribution and no doubt found generally throughout the Philippines.

ARTHONIA CINNABARINA Wallr. var. VIOLACEA (Pers.) Nyl.

Arthonia gregaria (Weig.) Koerber var. *violacea* (Pers.) Willey in VAINIO, Lich. Insul. Philip. 3 (1921) 305.

Spores mostly 8 in the asci at last becoming brown, 5 to 6 locular, breadth 7 to 9.3 μ, length 20 to 28 μ. Collected near

the School of Forestry, Laguna Province, on tree trunks; altitude about 250 meters. Also obtained near Odiongan, Tablas Island; these specimens had spores straight or slightly curved, colorless at first, then brown. They were 6 to 9 μ wide and 17 to 24.8 μ long.

The only previous Philippine record was from Sablang, Benguet Subprovince, Luzon. This is a cosmopolitan lichen.

BACIDIA BICOLOR Vainio.

Growing on trunks of *Champaca* at Novaliches, Rizal Province, Luzon. Spores up to 7 locular: 2 to 3.5 μ wide and 27 to 43 μ long. The only other specimen known of this lichen was collected at Taytay, Rizal Province.

BÆOMYCES ABSOLUTUS Tuck. var. STIPITATA (Mont.) Vainio.

Collected by Mary Strong Clemens at Haight's Place, Benguet Subprovince, Luzon; altitude about 2,460 meters. The only other Philippine record was from Mt. Pulog, Benguet, at about 2,000 meters.

This lichen occurs in the warmer parts of the Americas and in New Zealand.

BÆOMYCES CRENULATUS Hepp var. SUBSESSILIS (Mont. and v. d. Bosch) Müll. Arg.

On rocks along the trail between Banaue and Mt. Polis Rest House, at 1,000 meters. A prior Philippine record is from Benguet, Luzon, at 2,000 meters. First known from Java.

BUELLIA LAURICASSIÆ (E. Fr.) Vainio.

Tuao, Cagayan Province, where I found it on the trunks of the *Areca* palm. Also on various trees at Kiangan, Ifugao Subprovince, Luzon. Spores 6 to 9.75 μ wide and 15.5 to 26.5 μ long.

Previous Philippine records are from Sabtan Island, Batanes Islands, and from Kabankalan, Negros Occidental Province.

Widely distributed in both hemispheres.

BUELLIA PITHECOLOBI Vainio.

Collected at Camp Lookout. Spores 8, 12, and 16 in the asci, 4 to 6 μ wide and 8.5 to 13 μ long. Previously known only from Hacienda Louisiana, Bago, Negros Occidental Province.

CLADONIA BACILLARIS (Del.) Nyl.

Found growing on the stump of a tree fern on Mt. Polis, Mountain Province, Luzon. The only other Philippine record is

from Mt. Pauai, Benguet. Widely distributed in the temperate zone.

CLADONIA FURCATA (Huds.) Schrader.

Occurring on earth at Dansalan, Lanao Province, Mindanao. Previously collected at numerous localities in the Mountain Province, Luzon. Found generally over the earth.

COCCOCARPIA CRONIA (Tuck.) Vain.

On the Angat River near Angat Dam, Bulacan Province, Luzon, on tree trunks; altitude about 250 meters. Also on trees at Camp Lookout, and at Cabalian, Leyte. Previous Philippine records are from Benguet and Pampanga Province; Larena, Iloilo Province; and Taytay, Palawan.

I have also collected it on Ovalau Island, Fiji, and at Papeari, Tahiti.

COCCOCARPIA CRONIA var. ISIDIOPHYLLA (Müll. Arg.) Vainio.

On trees at Camp Lookout. Previous Philippine records are Mount Banahao, Laguna Province; Camiguin Island; and Butuan, Mindanao.

COCCOCARPIA CRONIA var. ISIDIOSA (Müll. Arg.) Vainio.

Near Odiongan, Tablas Island. Near Camp Lookout on *Cocos nucifera*. I also collected in Kulambangra Island, Solomon Islands, altitude about 30 meters. Earlier Philippine records are from Sablang, Benguet Subprovince; San Antonia, Laguna Province; and Irosin, Sorsogon Province, Luzon.

Coccocarpia cronia and its varieties are widespread throughout tropical and subtropical regions.

COCCOCARPIA PELLITA (Ach.) Vainio.

Growing on tree trunks at Kiangan, Ifugao Subprovince, at 800 meters and also along the trail between Banaue and Bontok, Mountain Province, at 1,150 meters. At Camp Lookout on *Cocos nucifera* at 500 to 650 meters, and at Cabalian, Leyte. I also collected it at Auki, Malaita Island, Solomon Islands.

COCCOCARPIA PELLITA var. PARMELIOIDES (Hook.) Müll. Arg.

On the bark of trees at Cabalian, Leyte. Previous Philippine records are from Benguet Subprovince, Baguio and Mt. Pulog; Rizal Province; Luzon; Libacao, Capiz Province, and Iloilo Province, Panay; and Taytay, Palawan.

Coccocarpia pellita and its various forms are very widespread in both hemispheres.

COLLEMA FURFURACEUM (Arn.) DuRietz.

Camp Lookout, on trunks of various trees. New to the Philippines.

COLLEMA NIGRESCENS (Huds.) DC.

On trunks of trees at Camp Lookout. New to the Philippines.

CYCLOGRAPHA INTERPOSITA Vainio.

Tablas Islands, north of Odiongan. Spores four-locular, measuring 3.1 μ in width by 13 to 18 μ in length. A Philippine lichen known from Antipolo, Rizal Province; Mt. Makiling, Laguna Province; and Mt. Mariveles, Bataan Province, Luzon; and from Balabac.

DIPLOSCHISTES CINEREO-CÆSIUS (Sw.) Vainio.

On earth beside the trail between Tinglayan and Lubuagan, Kalinga Subprovince, Luzon; altitude about 800 meters. Spores 7.5 to 9.5 μ wide by 20 to 26 μ long. The only other Philippine record is from Pauai, Benguet Subprovince. Widely distributed in tropical and subtropical regions.

GRAPHINA COPELANDI Vainio.

On trees near Camp Lookout, and on Tablas Island near Odiongan. Spores 9 to 21.7 μ broad by 37 to 62 μ long.

A Philippine lichen only known before from Lamao, Bataan Province, Luzon.

GRAPHINA COPELANDI var. CHAPMANI Herre, var. nov.

Sporæ subobscurus et quasi-luteolus, alius modi similas. Ad corticem arboris, Los Cuernos de Negros, Provincia Negros Oriental.

This variety differs from typical specimens in having the spores dark instead of colorless; they become nearly yellow and dark, but not dark enough to be called a Phæographina. Growing on the trunks of trees at Camp Lookout.

GRAPHINA HOLOLEUCA (Mont.) Müll. Arg.

On trees near the School of Forestry, Laguna Province, altitude 250 meters. Spores solitary, 28 to 34 μ wide and 93 to 130 μ long; transverse locules 6 to 8; longitudinal 18 to 30. Hitherto known only from Java and new to the Philippines.

GRAPHINA ORIENTALIS A. Zahlbr.

On exposed roots of trees beside the sea at Sitankai, Sulu Province, at an altitude of not more than half a meter and frequently covered with salt spray. Specimens distributed as

No. 3715, Kryptog. Exsiccat. Nat. Hist. Museum, Wien, Austria.

A Philippine lichen previously collected at Taytay, Palawan; Dinagat Island; Guimaras Island, and Biliran Island.

GRAPHINA PHILIPPINA Vainio.

On tree trunks at Camp Lookout. Spores solitary, 28 to 40 μ by 108 to 148 μ muriform multilocular; transverse locules 30 vertical series 8 (varying from 6 to 10 but not in my specimens).

Previously known from Mt. Bulusan, Irosin, Sorsogon Province, Luzon. Spores 2, 3, or 4 in the asci, and rarely also solitary.

GRAPHINA STREBLOCARPA Müll. Arg.

On trunks of *Cocos nucifera*, Gorror, Pelew Islands, at an altitude of 30 to 50 meters. Some of my specimens were distributed as No. 3649, in the Kryptogam, Exsicc. of the Natural History Museum of Vienna, Austria. Known previously from Java, Celebes, and Amboina. No doubt it occurs in Mindanao and the Sulu Islands.

GRAPHIS AFZELI Ach.

On bark of trees near Odiongan, Tablas Island. New to the Philippines. Widely distributed in the warmer parts of the earth.

GRAPHIS EUGENIÆ Vainio.

Camp Lookout, on the bark of trees. Spores 3.2 to 4 μ in width and 14.2 to 18 μ in length. A Philippine lichen previously known only from Luzon, at Dupax, Nueva Vizcaya Province; Mt. Mariveles, Bataan Province; and Mt. Bulusan, Irosin, Sorsogon Province. Canlaon Volcano, Negros.

HÆMATOMMA PUNICEUM (Ach.) Vainio.

On trees at Camp Lookout. Spores mostly curved, measuring 3 to 4 μ in breadth and 43 to 55 μ in length. Previous Philippine records are from Mt. Apo, Davao Province, Mindanao, and from Pauai and Mt. Pulog, Benguet, Luzon. Found in tropical and subtropical regions, in the southern United States and in Europe.

LEPTOGIUM CÆSIUM Vainio.

On *Cocos nucifera* at Camp Lookout at 500 to 600 meters. Also on various other kinds of trees at elevations of 1,000 to

1,400 meters on Los Cuernos de Negros. Previously known in the Philippines from Benguet, Rizal, and Bataan Provinces, Luzon. A widely distributed lichen.

LEPTOGIUM GRANULANS Vainio.

On tree trunks at Camp Lookout. Hitherto known only from Rizal Province, Luzon, where it was found growing on mossy rocks. Not known outside the Philippines.

LEPTOGIUM JAVANICUM Montagne.

Baguio, Mountain Province, Luzon, growing on the trunks and branches of trees. Spores ellipsoid or short ellipsoid and muriform multilocular with 3 or 4 transverse septæ and one longitudinal septum; 11 to 14 μ wide and 21.7 to 28 μ long. Prior Philippine records are from Bontok, Mountain Province, Rizal Province, and Irosin, Sorsogon Province, Luzon; Antique Province, Panay; and Bulacan, Mindanao. Occurs generally in tropical regions.

LEPTOGIUM MARGINELLUM (Sw.) S. F. Gray.

On the bark of trees and on dead wood at Camp Lookout. The apothecia are numerous and very minute. New to the Philippines.

LEPTOGIUM MOLLUCCANUM (Pers.) Vainio.

On tree trunks, Mt. Makiling, Laguna Province, Luzon, altitude about 1,000 meters; spores 6.5 to 8 μ and 15.5 to 21 μ long. On various trees on "Sacred Mount" near Dansalan, Lanao Province, Mindanao, altitude 800 meters; spores 7.75 to 8.75 μ wide and 17.75 to 21 μ long.

I also collected this species at Papeari, Tahiti, near sea level.

Earlier Philippine records are from Mt. Bulusan, Irosin, Sorsogon Province, Luzon; Antique and Capiz provinces, Panay; and on Canlaon Volcano, Negros; altitude about 1,400 meters.

LEPTOGIUM PACIFICUM Vainio.

On rocks beside the mountain trail above Banaue, Ifugao Subprovince, Luzon, at about 1,100 meters; spores 5 to 6.5 μ by 27 to 31 μ. The only other record is from Bontok, Mountain Province.

LEPTOGIUM TREMELLOIDES (L.) S. F. Gray var. AZUREUM (Sw.) Nyl.

Widely distributed in the Philippines, growing on tree trunks and on mossy rocks. I have collected it as follows: Between Banaue and Bontok, Mountain Province, at 1,100 meters, on mosses over rocks and also on trees; spores 9.5 to 12 μ broad and 30 to 36 μ long. Baguio, Mountain Province, about 1,600 meters. Lake Balinsasayao, Negros Oriental Province, on trees and rocks, at 1,200 meters; on rocks and trees at Biliran Island. Kenami, Cotabato Province, altitude 3 meters; slopes of Mt. Apo at 800 meters, on the trail from Balatutam, Davao Province, Mindanao. Near the town of Coron, Busuanga Island, at 15 or 16 meters.

As *Leptogium azureum* this was recorded by Vainio from many localities from Apayao and Lepanto, in northern Luzon, to Balabac and Mindanao.

I have also collected it at Nuka Hiva, one of the Marquesas Islands, altitude 300 meters; at Kulambangra, one of the Solomon Islands; and at Papenoo, Tahiti. Spores from the last named locality were 9.4 to 12.4 μ broad by 20 to 28 μ long. This lichen is of very wide distribution in tropical and warm temperate regions.

LOBARIA DISCOLOR (Bory) Hue.

Growing on tree trunks beside the trail between Banaue and Bontok, Mountain Province, altitude 1,000 meters. Spores bilocular, 9.3 μ by 24.8 μ. Previously recorded from Mt. Arayat, Pampanga Province, Luzon. Generally distributed through the tropics.

LOBARIA ISIDIOSA (Müll. Arg.) Vainio.

On the trunks of trees along the trail from Banaue to Bontok, Mountain Province, Luzon, altitude 1,000 meters. Baguio, Mountain Province, at 1,600 meters; spores 3-septate and also bilocular, 8 to 10 μ wide and 20 to 31 μ long. Mount Caua, Bontok Province, Luzon.

Previous Philippine records are from Pauai, at 2,250 meters, and Mt. Pulog, Mountain Province, Luzon. Known originally from the American tropics and said also to occur at the isle of Bourbon in the Indian Ocean.

LOBARIA RETIGERA (Bory) Trevis.

I collected this on the trunks and twigs of trees at Baguio, at 1,600 meters, and on the trail between Banaue and Bontok,

Mountain Province, at 1,000 meters; spores 7 to 10 μ broad and 26 to 30 μ long. Prior Philippine records are from Mt. Halcon, Mindoro, and from Mt. Malindang, Misamis Province, Mindanao.

I also collected this lichen at the Trout Hatchery, Cameron Highlands, Pahang, Malay Peninsula; altitude about 1,700 meters. Found generally in the tropical and subtropical regions.

I also collected it at Nuka Hiva one of the Marquesas Islands, at 300 meters altitude; at Papenoo, Tahiti; and at Kulambangra, one of the Solomon Islands. Spores of the Tahiti specimens measured 9.4 to 12.4 μ by 20 to 28 μ. This is a lichen widely distributed in warm temperate and tropical regions.

MELANOTHECA ANOMALOIDES Vainio.

On the bark of *Delinea indica* near the School of Forestry, Laguna Province, Luzon; altitude about 150 meters. Spores 4–locular, 6 μ wide and 14 to 18.6 μ long. The only other record of this Philippine lichen is from Rizal Province.

MEGALOPSORA CYLINDROPHORA (Taylor) Vain.

On the trunks of trees beside the trail between Banaue and Bontok, Mountain Province, Luzon; elevation 1,000 to 1,150 meters. On trees at Antipolo, Rizal Province.

Originally described from Madras, India. Vainio had it from Pangasinan Province, Lanao, Bataan Province, and from Rizal Province, Luzon.

OCELLULARIA DEFOSSA Müll. Arg.

Growing on the trunk of a tree at Sitankai, Sulu Province, at an altitude of about 2 meters. New to the Philippines. Hitherto known only from the island of Timor, Indonesia.

OPEGRAPHA OBTUSELLA Nylander.

On *Cocos nucifera* on the campus of Silliman University, Dumaguete. My specimens were distributed as No. 3574, Kryptogam. Exsicc., of the Natural Museum of Wien, Austria. Unfortunately the Museum labelled them "Galapagos Islands," a group off the coast of Ecuador, South America. I also collected his species from trees at the College of Agriculture, Laguna Province. Previously known from Timor, Indonesia.

OPEGRAPHA ROBUSTA Vainio.

On trees in the forest between Balatukan and Digos, Davao Province, Mindanao; altitude about 500 meters. Spores 12 to

18 locular and 3.5 μ broad by 6 μ long. A Philippine lichen known before only from Mount Mariveles, Bataan Province, Luzon.

PANNARIA LEPIDOPHORA Vainio var. SIMPLICIOR Vainio.

Growing on trees at Camp Lookout; the apothecia is reddish to blackening; there are no isidia on the apothecial margin. Found on *Cocos nucifera, Artocarpus* sp., and on other trees. Previously known only from Pauai, Benguet, at 2,100 meters.

PANNARIA MARIANA (E. Fr.) Müll. Arg. var. FUNEBRIS (Krempelh.) Vainio.

My specimens were taken at Mt. Angela, Tayabas Province, now Quezon Province, Luzon. This variety occurs in the Philippines from the Batanes Islands to Mindanao, and is widely distributed in the tropics.

PANNARIA MARIANA var. RADIATA (Nyl.) Vainio.

My specimens were found on trees at Tablas Island and at Camp Lookout. The spores are variable, 6 to 7.5 μ by 11.5 to 15 μ and also 9.3 to 11 μ wide by 15.5 to 18 μ long. It occurs on trees and mossy rocks throughout the Philippines. *Pannaria mariana* is found in its various forms in all warm regions in the world.

PANNARIA STYLOPHORA Vainio var. DISSERPENS Vainio.

Growing on mossy rocks beside the trail between Banaue and Bontok, Mountain Province, Luzon; altitude 1,200 meters. Also on the trail above Banaue, at 1,100 meters. On *Cocos nucifera* at Camp Lookout. Cabalian, Leyte, on trees. On trees, at altitude 700 meters, Bukidnon Province, Mindanao.

A Philippine lichens already known from Pampanga Province, Mount Arayat, Benguet Subprovince, Rizal Province, and Irosin, Sorsogon Province, Luzon. Iloilo Province, Panay. Taytay, Palawan. Agusan Province, Zamboanga Province, and Camp Keithley, Lanao Province, Mindanao.

PANNARIA STYLOPHORA var. PERCONFLUENS Vainio.

On the bark of trees at Mt. Irid, Rizal Province. Vainio had it also from Rizal Province and from San Antonio, Laguna Province, all on Luzon.

I found this variety growing on *Cocos nucifera* trunks at Papeari, Tahiti, and a specimen was collected from the trunk of a bread-fruit tree at Majuro Island, Majuro Atoll, Marshall Islands, by Alexander Spoehr.

PARMELIA CLAUDELI (Harm.) Vain. var. CLEMENSÆ Vain.

On trees at Baguio, Mountain Province, Luzon, at 1,650 meters. Hitherto known only from the collections by Mrs. Mary Strong Clemens at Camp Keithley, Lanao Province, Mindanao.

PARMELIA CORNICULANS Nylander.

Found growing on rocks at Baguio, Mountain Province. Earlier Philippine records are from Mt. Tonglon, Benguet Subprovince, and from the Zambales Mountains, Luzon, and Mount Halcon, Mindoro, on trees as well as rocks. Known only from Java and the Philippines.

PARMELA CRISTIFERA Taylor.

On mossy tree trunks beside the trail between Tinglayan and Lubuagan, Kalinga Subprovince, Luzon, at 700 meters; also from Baguio, at about 1,650 meters. Vainio had a specimen from Davao, Mindanao. This handsome lichen is found in almost all warmer regions.

PARMELIA MANILENSIS Vainio.

A fragment was collected from a mossy rock at Baguio, Mountain Province, Luzon. The only other known specimen came from Mt. Tonglon, Mountain Province.

PARMELIA MERRILLI Vainio.

Two different lots were collected at Baguio, growing on trees, at 1,600 and 1,700 meters. Thallus margin ciliate, the apothecia very large, up to 23.5 mm in diameter. Spores 14 to 18 μ broad by 22 to 30 μ long. A Philippine lichen previously known from Mt. Tonglon, Benguet Subprovince, and the Zambales Mountains, Luzon, and from Mt. Halcon, Mindoro.

PARMELIA PERLATA (Huds.) Ach.

Growing on tree trunks near the Angat River Dam; altitude about 270 meters. Already known in the Philippines from Camp Keithley, Lanao Province, Mindanao, where it grew on trees, and from Zamboanga, growing on rocks. A lichen of world wide distribution.

PARMELIA SUBLÆVIGATA Nyl. forma ISIDIOSA Müll. Arg.

I collected this variety, which is new to the Philippines, on trees at Camp Lookout; spores but 6 in the asci, 6.3 to 9.3 μ wide and 7 to 12.5 μ long.

Parmelia sublaevigata Nyl., a species widely distributed over the earth, was listed by Vainio under the name of *Parmelia hookeri* Taylor from Baguio, where it grew on *Pinus insularis*.

PARMELIA TINCTORUM Despreaux.

This is listed as *Parmelia coralloidea* by Vainio. He had a specimen from Camp Keithley, Lanao Province, Mindanao, collected by Mrs. Mary Strong Clemens.

I found it growing on rocks and trees at Camp Lookout, altitudes 500, 600, and 700 meters. Found in warm regions everywhere.

PERTUSARIA SUBMULTIPUNCTA Nyl.

Near Odiongan, Tablas. The sorediate verrucæ turn yellow with K, and somewhat rubescent with K plus C.

Vainio had it from the bark of *Pinus insularis* at Baguio and from elsewhere in Benguet Subprovince, at 2,000 meters. Occurs in Japan and the Philippines.

PERTUSARIA VELATA (Turn.) Nyl.

On tree trunks, Tablas Island. Spores solitary, 24 to 29 μ wide by 93 to 130 μ long. Thallus finally purplish red with K; apothecial warts red with C; surface of the thallus more or less red, the medulla bright red with C. Also from Mt. Bulusan, Irosin, Sorsogon Province, Luzon.

Earlier Philippine records are from Benguet Subprovince, Luzon, at 1,800 meters and from Capiz, Panay. A species of world-wide distribution.

PHÆOGRAPHINA ALBIDO-LIVENS (Vain.) Herre.

Between Tuao and Solano, on a tree beside the trail, Cagayan Province, and on trees at Montalban Gorge, Rizal Province, Luzon. Spores solitary and at first colorless, but eventually becoming dusky; hymenium and spores violaceous with Iodine. Spores 29 to 34 μ wide and 93 to 121 μ long; longitudinal locules 26 to 32, transverse locules 6 to 8, rarely 12.

Recorded as *Graphis albidolivens* by Vainio from Laguna Province, and Mt. Bulusan, Irosin, Sorsogon Province, Luzon. A Philippine lichen which I have transferred because of its dusky spores.

PHÆOGRAPHINA CÆSIOHIANS (Nyl.) Redinger.

On trees at Novaliches, near Manila, Rizal Province; spores 15 to 18.6 μ wide by 34 to 40 μ long. New to the Philippines

and hitherto known only from the small Island of Labuan, on the west coast of Borneo.

PHÆOGRAPHINA EXSERTISSIMA (Vain.) A. Zahlbr.

This Philippine lichen was described by Vainio from Benguet, Mountain Province, where it occurred at 1,500 meters; from Dupax, Nueva Vizcaya Province, and from Mt. Bulusan, Irosin, Sorsogon Province, Luzon.

Its known range is greatly extended by my collection of it at Gorror, Pelew Islands, where it grew on *Cocos nucifera,* altitude about 30 meters. Spores solitary, muriform multicular, breadth 20 to 28 μ length 87 to 134 μ. At least part of the apothecia are dimidiate, while others are entire.

PHÆOGRAPHINA FLEXUOSA (Nyl.) Müll. Arg.

On tree trunks at Camp Lookout; spores in fours in the asci, and measure 12 to 16 μ in width and 34 to 40 μ in length. The only other Philippine specimen known was collected by Hugh Cuming at Manila about 1836, and recorded by Nylander. Vainio calls it *Glyphis flexuosa.* It occurs elsewhere from Labuan Island and from Singapore.

PHÆOGRAPHINA PERRIGIDA (Vain.) A. Zahlbr.

On tree trunks at Camp Lookout. A Philippine lichen originally described from Mt. Bulusan, Irosin, Sorsogon Province, Luzon. Spores 4 in my specimen, 15 to 23 μ broad and 50 to 69 μ long. In the type the spores are in eights and also in twos.

PHÆOGRAPHINA TORQUESCENS (Nyl.) Redinger.

On trees on the slopes of Los Cuernos de Negros, altitude 500 to 700 meters. Spores 9.5 to 12.5 μ once 17 μ wide and 31 to 40 μ long, given as 8 septate by Redinger, but mine are 7 to 9 septate. Known from Java and Labuan and new to the Philippines.

PHÆOGRAPHIS DENDROIDES (Leighton) Müll. Arg.

On trees at Camp Lookout. Spores six locular, 4 to 8 in the asci, arranged in two rows; 6.2 to 9.3 μ by 18 to 12 μ.

Prior Philippine records are from Irosin, Sorsogon Province, Luzon; Polillo; Biliran; and Taytay, Palawan. First described from Ceylon.

PHÆOGRAPHIS MITIS (Vain.) Redinger.

Near Camp Lookout. Spores 6 to 7.5 μ wide and 21 to 26 μ long. A Philippine lichen originally described by Vainio from Taytay, Palawan, under the name of *Graphis mitis.*

PHÆOGRAPHIS SEMIGLYPHIS (Vain.) Red.

On trees at Tablas Island; spores 7.75 μ wide by 18.6 to 23 μ long. On tree trunks near Camp Lookout; spores 4.6 to 6 μ broad by 18.6 to 23 μ long. A Philippine lichen only known before from Taytay, Palawan.

PHYSCIA CRISPA (Persoon) Nyl.

On rocks at 800 meters, Los Cuernos de Negros, above Luzuriaga. Recorded by Vainio from Baliwag, Bulacan Province, and Taytay, Rizal Province, Luzon. Usually on bark but also on dead wood and rocks throughout the tropics and subtropical regions.

PHYSCIA CRISPA (Pers.) Nyl. var. HYPOMELA Tuck.

Growing over mosses on the bases of trees, Mt. Irid, Rizal Province, Luzon. Vainio had it from Bago, Negros Oriental Province.

PHYSCIA PICTA (Sw.) Nyl.

On *Cocos nucifera* on the campus of Silliman University, Dumaguete; Camp Lookout at 500 meters, and on the slopes of Los Cuernos de Negros at 650 meters. At Dansalan and Tamparan, Lanao Province, altitude 700 to 750 meters; on trees at Kenami, Cotabato Province, Mindanao, altitude about 3 meters; spores 6 to 7.5 μ wide and 15 to 18 μ long.

Prior Philippine records are Atimonan, Tayabas Province, Luzon, and Guimaras, all on *Cocos nucifera*. Found from the southern United States throughout the American and Pacific tropics.

PHYSMA BYRSINUM (Ach.) Müll. Arg.

Abundant and widely distributed in the Philippines from the north of Luzon to Mindanao. I collected it also at Papenoo, Tahiti; spores 8.5 to 9.5 μ wide and 11.5 to 16 μ long.

PHYSMA RADIANS Vainio.

Santa Fe, Nueva Vizcaya Province, Luzon, at about 400 meters. Spores globose, subglobose, and ellipsoid; up to 18.6 μ in diameter when globose, and measuring 7.75 to 9.5 μ by 12 to 18 μ when ellipsoid.

Near Cabalian, Leyte; spores ellipsoid, 7.75 to 8.5 μ broad by 11.5 to 24 μ long.

Near Malaybalay, Bukidnon Province, Mindanao; altitude 800 meters. Spores globose to ellipsoid, 10 μ in diameter and

also 6.5 to 8 μ to 11.5 to 24 μ. A Philippine lichen hitherto known only from Bataan Province, Luzon.

PYXINE COPELANDI Vainio.

On *Oreodoxa regia* at the College of Agriculture, and also at the College of Forestry, Laguna Province, Luzon; altitude 100 and 250 meters. Tablas Island. Camp Lookout.

A Philippine lichen, described from Capiz, Panay.

PYXINE DISSECTA (Fée) Vainio.

A lichen of the warmer parts of the Americas but abundant and widespread in the Philippines. Common on *Oreodoxa regia* around the Institute of Science and elsewhere in Manila; spores 4.9 to 6.5 μ wide and 13 to 18.6 μ long. Abundant on the trunks of *Cocos nucifera* on the campus of Silliman University and elsewhere in Dumaguete at an altitude of 10 meters or so; also at Camp Lookout. Romblon, on *Cocos nucifera.* On trunks of the *Areca* palm at Tuao, Cagayan Province, and on the campus of the College of Agriculture, Laguna Province, Luzon.

Previous Philippine records are on *Cocos nucifera* at Guimaras Island and at Cavilla Island in the Sulu Sea.

PYXINE ENDOCHRYSOIDES (Nyl.) Degelius.

On volcanic rocks and on *Cocos nucifera,* at Camp Lookout and vicinity. New to the Philippines; a Japanese and Hawaiian lichen.

PYXINE ENDOLEUCA (Müll. Arg.) Vain.

On *Cocos nucifera,* campus of Silliman University, Dumaguete; spores 3.8 to 7.75 μ wide and 12.4 to 21.7 μ long. The only other Philippine record is from Cavilla Island, Sulu Sea. An African lichen.

PYXINE RETIRUGELLA Nyl.

On trees at Camp Lookout; thallus isidiate to sorediate, black beneath; spores 6.5 to 10.8 μ broad and 15 to 21.7 μ long.

PYXINE RETIRUGELLA var. CAPITATA A. Zahlbr.

This occurs with the species at Camp Lookout. Hitherto known only from the Hawaiian Islands. The species is widespread in the tropics.

PYXINE SOREDIATA (Ach.) Mont.

On *Cocos nucifera* on the campus of Silliman University at Dumaguete, altitude 5 to 6 meters; also at Camp Lookout. On

trees at Kenami, Cotabato Province, Mindanao, altitude about 7 meters. New to the Philippines and general throughout the tropics.

SARCOGRAPHA HETEROCLITA (Mont.) A. Zahlbr.

Brooke's Point, Palawan; spores 6 to 6.5 μ wide by 18 to 20 μ long. Previously known in the Philippines from Irosin, Sorsogon Province, Luzon, and from the banks of the river Basugan, Zamboanga Province, Mindanao. Widely distributed in tropical Asia and in the tropical Pacific.

SARCOGRAPHA IMPRESSO-PUNCTATA (Vain.) A. Zahlbr.

Brooke's Point, Palawan; spores 8, arranged in 2 rows in the asci, 6-locular; 5 to 6.5 μ broad and 14 to 21.7 μ long. This Philippine lichen was only known before from Mt. Mariveles, Bataan Province, Luzon.

SARCOGRAPHA LABYRINTHICA (Ach.) Müll. Arg.

On the bark of cinchona trees near the School of Forestry, Laguna Province, altitude about 200 meters; Kiangan, Ifugao Subprovince, Luzon; altitude about 670 meters; spores 5 to 6 μ wide and 14 to 18.5 μ long. Tablas Island. Camp Lookout; spores 5 to 6 μ by 14 to 18.6 μ long.

Earlier Philippine records are from Rizal Province and Irosin, Sorsogon Province, Luzon; and Taytay, Palawan. General in the tropics.

SARCOGRAPHA RAMOSO-CONNEXA (Vain.) Red.

Tablas Island, on trees; spores 4.7 to 5 μ wide by 12.5 to 19 μ long. A Philippine lichen, recorded by Vainio under the name of *Graphis ramoso-connexa* from Taytay, Palawan.

STEREOCAULON CHLOROCARPOIDES A. Zahlbr.

On mossy rocks at Kiangan, Ifugao Subprovince, Luzon, at 800 meters altitude. A Formosan lichen now reported from the Philippines for the first time.

STEREOCAULON NESÆUM Nylander.

On rocks beside the trail above Banaue, Ifugao Subprovince, at 1,150 meters. Of general occurrence in the Mountain Province, and on Mt. Pinatubo, Zambales Province, and Mt. Mariveles, Bataan Province, Luzon. Mt. Malindang, Misamis Province, Mindanao.

Sangi Island, one of the Sangir Islands between Mindanao and Celebes; on earth and rocks at about 700 meters altitude.

In the Cameron Highlands, Pahang, on rocks near the Trout Hatchery. These unusually fine specimens grew on granite at an altitude of 1,600 or 1,700 meters. A widespread tropical species.

STICTA AURATA Ach.

Bangui, Benguet Subprovince, at 1,600 meters. Previously recorded from Benguet and Pauai, Mountain Province, at 2,100 meters. Occurring generally in warm temperate and tropical regions.

STICTA GILVA (Thunb.) Malme.

On trees at Lake Balinsasayao, Cuernos de Negros, at a little more than 1,000 meters. Vainio recorded it from Mt. Tonglon, Pauai, and Benguet, Mountain Province, Luzon, at 1,500 to 2,100 meters; and Mt. Apot, Davao Province, Mindanao, at 1,800 meters.

STICTA SULPHUREA Schaerer.

This is recorded by Vainio as *Pseudocyphellaria quercifolia* (Taylor) Vainio. I have it from Baguio, Mountain Province, and the summit of Mt. Mariveles, Bataan Province, Luzon. Also from Leyte, without specific locality. Vainio had numerous specimens from high mountains all over Luzon, from Mindoro, and from Mt. Malindang and Camp Keithley, Lanao Province, Mindanao. One may confidently expect it on high mountains anywhere in the Philippines. Elsewhere it is known from tropical Asia, Ceylon, the East Indies, and Australia.

STICTA SINUOSA Persoon.

Irosin, Mt. Bulusan, Sorsogon Province, Luzon. On trees at Lake Balinsasayao, Los Cuernos de Negros, at 1,000 meters. The under side of the thallus with pale, nearly white, and rather sparse rhizoids, which may become dense, brown, and feltlike centrally; spores brown, bilocular, 9 to 15 μ broad and 26.5 to 38.5 μ long. Recorded from the "Philippines" by Nylander, without definite locality. Elsewhere known from tropical America.

TOMASELLIA QUEENSLANDICA Müll. Arg.

On tree trunks at Sitankai, Sulu Province, elevation about 2 meters; spores 6.2 to 12.4 μ by 18 to 25 μ. New to the

Philippines. Hitherto known only from tropical Queensland, Australia.

TRYPETHELIUM ELEUTERIÆ Sprengel.

On tree trunks above Lake Balinsasayao, Negros Oriental Province, at 1,100 meters. A pantropical lichen, now recorded for the first time from the Philippines.

USNEA HOSSEI Vainio.

On trees on the eastern slope of Los Cuernos de Negros, altitude 1,200 meters. Vainio described a specimen from Lamao, Bataan Province, Luzon, under the name of *Usnea trichodea* var. *rubiginosa* (Hepp). Motyka, the world authority on *Usnea* puts it under *U. hossei*, a lichen of Siam and the Malay Archipelago.

USNEA LONGISSIMA Ach.

A typical specimen of this cosmopolitan lichen, was collected at Santa Inez, Rizal Province, Luzon; approximate altitude 265 meters. Vainio had specimens from Mt. Data, Lepanto Subprovince, and Pauai, Benguet Subprovince, Luzon, both at 2,100 meters.

USNEA MARIVELENSIS (Vain.) Motyka.

On trees at Lake Danao, Sibulan, Negros Oriental Province; altitude about 975 meters. A Philippine lichen hitherto known only from the summit of Mt. Mariveles, Bataan Province, Luzon.

USNEA MISAMISENSIS (Vain.) Motyka.

On trees beside the trail between Banglad and Lubuagan, Kalinga Subprovince, Luzon, at about 900 meters. Vainio had specimens from Mt. Data, Lepanto Subprovince, Luzon, and Mt. Malindang, Misamis Province, Mindanao.

Motyka found, in studying the Usneas of the world, that this Philippine lichen is widely distributed from China and India throughout Indonesia to the Pacific Islands and Australia.

USNEA NEO-CALEDONICA (Harmand) Motyka.

I collected typical specimens at Vila, Efate Island, New Hebrides, on trees near sea level; specimens determined by Motyka. Hitherto known only from New Caledonia.

USNEA ONCODES Stirton.

I obtained typical fertile specimens from trees growing near Lake Tondano, North Celebes, at an approximate altitude of 750 meters. Hitherto known only from New Zealand and Java.

No doubt this lichen occurs in the mountains of southern Mindanao and the Island of Jolo, and should be looked for in those regions.

USNEA SQUARROSA Vain.

On trees at Malabang, Lanao Province, Mindanao; altitude about 25 or 30 meters. When treated with a solution of KOH the medulla turns yellow, then red. Vainio had specimens from Vigan, Mount Arayat, and Todaya, Luzon; Davao Province and Camp Keithley, Lanao Province, Mindanao.

This lichen is a native of Sumatra and Sumbawa also and no doubt occurs all through Indonesia.

VERRUCARIA CALCISEDA DC.

On rocks in a great gorge beside Camp Lookout; altitude about 660 meters. Spores 9 to 12.5 μ broad and 18 to 28 μ long. This lichen is new to the Philippines. It is widespread in Europe, Asia, and North America, and also occurs in the Hawaiian Islands.

STUDIES ON PARAGONIMIASIS, I

THE MOLLUSCAN AND CRUSTACEAN HOSTS OF PARAGONIMUS IN THE PHILIPPINES

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ONE PLATE

INTRODUCTION

Supported by generous grants-in-aid from the University of the Philippines a long-range program to study paragonimiasis in the Philippines was started by the author in the early part of 1954. This report is the first of what is hoped will be a long series of papers resulting from investigations conducted under this program.

Many local medical authorities believe that paragonimiasis is a rare disease in this country and therefore of no practical medical or public health significance. This belief is based on the great infrequency that cases have been recognized and on the greater infrequency of published case reports especially by workers in Manila. The defects of gauging prevalence on such basis are obvious and it appears reasonable to the author to withhold evaluation of the importance (or non-importance) of this disease in this country until evidence of a more adequate and reliable nature becomes available. Such an attitude seems wise, since it is known that in certain situations, as found in Korea and Japan, paragonimiasis is a medical and public health problem of considerable importance.

Although paragonimiasis has been known to be endemic in the Philippines for nearly fifty years, a rather sporadic and limited interest in it has left glaring deficiencies in the knowledge and understanding of this disease as it is found locally. Local studies on paragonimiasis have been largely concerned with the pathology and/or clinical aspects and much of the published work consist of case reports by physicians who encountered the disease in their private practice, in hospitals or at the autopsy table. Of the ecology of paragonimiasis in the Philippine setting, almost nothing is known. Exhaustive field studies

have not been conducted; therefore no accurate information as to the prevalence of the disease in endemic areas is available. The extent and distribution of endemic areas are known but vaguely and incompletely since these have had to be inferred mainly from the place of birth and/or residence of a relatively few infected individuals. Such inference is subject to error because people move from place to place. Of greatest importance, the factors affecting the transmission and epidemiology of the disease in the local situation are yet unknown.

A better understanding of paragonimiasis in the Philippines, especially of its ecological aspects, has been held back by lack of certain basic information. Before any great headway can be made along this direction, the life cycle of *Paragonimus* in the native environment must be elucidated. Of primary importance in and essential to the life cycle study is the identification of the local intermediate hosts.

Realizing the value of such work, it is surprising to note that no attempts to identify the intermediate hosts of *Paragonimus* in the Philippines were apparently made from 1907, when Musgrave(1) first reported the endemicity of paragonimiasis, until 1941. This is in marked contrast to the progress made in understanding the transmission of this disease in other Oriental countries where it is also endemic. For instance, the crustacean hosts of *Paragonimus* in Formosa were identified by 1916(2) and the snail host by 1919.(3) In Korea, several species of both molluscan and crustacean hosts of importance were recognized by 1925.(4) In China where the disease was proven endemic as late as 1930–1931,(5,6) the snail and crustacean hosts were known by 1934–1935.(7,8)

PREVIOUS STUDIES TO IDENTIFY THE INTERMEDIATE HOSTS OF PARAGONIMUS IN THE PHILIPPINES

In 1941, Tubangui started his studies to elucidate the life cycle of *Paragonimus* in the Philippines. No Filipino scientist was better qualified to do this type of work; among Tubangui's achievements had been the identification of the intermediate host of *Schistosoma japonicum* in this country in 1932(9) and the clarification of the life history of *Echinostoma ilocanum* in 1933.(10)

In his field investigations on *Paragonimus* in Naga, Camarines Sur in 1941, Tubangui found the trematode metacercariæ in fresh-water crabs which he identified as a species of

Potamon (*Potamon*). Since he based his recognition of the metacercariæ on both morphological evidence and feeding experiments, there can be no doubt that he was dealing with *Paragonimus*. The preliminary report of his findings was presented as an abstract(11) in the proceedings of a scientific conference sponsored by the puppet Republic of the Philippines under the Japanese in December, 1943. The abstract was lost during the last World War and is apparently no longer available. The only available report on Tubangui's 1941 studies appeared in a short paper in 1946(12) after his original data had been lost during the battle for the liberation of Manila in 1945. Tubangui corrected the name of the involved fresh-water crab from *Potamon* (*Potamon*) species to *Parathelphusa* (*Barythelphusa*) *mistio* (Rathbun) in 1947(13) and listed this epecies as the second intermediate host of *Paragonimus* in the Philippines.(14)

Because of World War II and its aftermath, Tubangui was unable to resume his field studies until 1948–1949. His untimely death in 1949 prevented his writing up the results of these, his last studies. A few handwritten notes were found among his effects and formed the basis for a preliminary report(15) written by his assistants in 1950. One of the details known about Tubangui's 1948–1949 studies is that he found infected crabs which he also thought were *Parathelphusa mistio* from localities other than the one in which he originally discovered them. It is also known that he was unsuccessful in his quest for the snail intermediate host until his last field trip when he obtained two infected individuals out of 1,986 snails he identified as *Brotia asperata*. These snails were collected from a stream in Barrio Mabini, Municipality of Casiguran, Sorsogon Province.

MATERIALS AND METHODS

In April, 1954, a party headed by the author made a survey for paragonimiasis in three barrios of the Municipality of Casiguran, Sorsogon Province. Snails and crabs from fresh-water streams in the study area were collected and examined for larval stages of *Paragonimus*. The identification of the metacercariæ in the crabs was based on morphology as well as on study of adults obtained after feeding to "clean" cats. The identification of the cercariæ from the snails was based on a careful study of their morphology, including comparison with Tubangui's original material. The morphology of some of the

larval stages of *Paragonimus* in this country will be described in the second paper of this series.(16) There is not the slightest doubt in the author's mind that he was working with the larvæ of *Paragonimus* in this investigation.

A portion of the collections of the crab and snail species that had been proved positive for *Paragonimus* larval stages was preserved in formalin and brought to the United States for identification. Those used for this purpose were collected from a stream in Barrio Boho, Casiguran, Sorsogon Province.

A few crabs were sent to Dr. Fenner A. Chace, Jr., Curator of the Division of Marine Invertebrates, Smithsonian Institutions, United States Natural Museum at Washington, D. C., in January, 1955. The pertinent portion of Dr. Chace's letter to the author on the identity of these crabs is quoted below.

> Further perusal of our records show that I was responsible for the name *Parathelphusa mistio* which, as noted in your letter of January 13, Dr. Tubangui was using for these crabs. In October, 1946, we received from the Division of Parasitology, Army Medical Center, Washington, D. C. (through Major George W. Hunter, III) three crabs collected by Dr. Tubangui at Naga, Camarines, Luzon. I tentatively identified these as a male and two females of *Parathelphusa* (*Barythelphusa*) *mistio* (Rathbun). The specimens you collected, also a male and two females, are somewhat different from those collected by Dr. Tubangui, although they are more like *P.* (*B.*) *mistio* than any other described species.
>
> Balss, ———, believed that all of these closely related forms belong to one variable species, *P.* (*B.*) *grapsoides* (H. Milne Edwards). In my opinion, Balss is likely to assign too little importance to differences that other authors believe to be of specific or subspecific value, but only a thorough study of the Philippine fresh-water crabs, based on extensive collections from various parts of the Islands, can decide the issue. For the present, the best that we can do is to say that both your specimens and those collected by Dr. Tubangui belong to the *P.* (*B.*) *grapsoides* species complex and that they are near, but probably not identical with, *P.* (*B.*) *mistio*. Until we know more about the variation exhibited by the Philippine species, I do not believe that anything would be gained by sending the specimens to Paris for comparison with the type of *P.* (*B.*) *mistio*. That species, incidentally, has Mindanao for its type locality.

Some snails were sent to Dr. R. Tucker Abbott of the Academy of Natural Sciences of Philadelphia in December, 1954. He identified the snails as *Brotia asperata* Lamarck form *dactylus* Lea.

RESULTS AND DISCUSSION

This investigation therefore incriminates the following as intermediate hosts of *Paragonimus* in the Philippines:

First intermediate host: the snail *Brotia asperata* Lamarck, 1822 (Plate 1, fig. 1).

Second intermediate host: the fresh-water crab of the *Parathelphusa* (*Barythelphusa*) *grapsoides* species complex (Plate 1, fig. 2).

These results confirm the report of Tubangui, *et al.*(15) on the snail species and revise the crab species reported by Tubangui(11, 12, 13, 14) as the first and second intermediate hosts of *Paragonimus* in the Philippines.

The fresh-water crabs of the Philippines have not been thoroughly studied. Rathbun(17) lists thirteen species of these crabs found in this country under the family Potamonidæ. Almost nothing seems to be known of the distribution and habits of the crab species identified as the second intermediate host of *Paragonimus*. It was observed during our collecting trips that these crabs could be found hidden under the rocks in the stream bed during the daylight hours. These crabs are probably nocturnal in habit since more of them could be collected at night with the aid of a torch. Some idea of the natural habitat of this crab may be gained from the following discussion of the snail species, *Brotia asperata*, since the two species inhabited the same streams in the study area.

Some information is available concerning the snail species, *Bortia asperata*, which is now confirmed as the first intermediate host of *Paragonimus* in the Philippines. Abbott's handbook(18) gives the taxonomic position of this snail as follows:

Phylum: Mollusca

Class: Gastropoda

Sub-class: Streptoneura

Order: Pectinibranchiata

Family: Thiaridæ

Genus: *Brotia* K. Adams, 1866

Species: *Brotia asperata* Lamarck, 1822

This same book devotes only a short paragraph, a portion of which is quoted below, to the genus *Brotia:*

This group of Thiaridæ is of no known medical importance. The shells are large for this family, reaching a length of two or three inches. They may be distinguished from all other Thiaridæ genera by the perfectly smooth mantle edge and multispiral rounded operculum. In the Philippines, *Brotia asperata* Lamarck, 1822 is a common species

found in the tiny, mountain brooks where the water is cool. This species will crawl out of water during a rain . . .

Members of the genus *Brotia* have heretofore been considered as of no medical importance. This is probably the reason that not much attention has been devoted to it. However, the family to which *Brotia* belongs, Thiaridæ, includes the majority of the snail species incriminated as intermediate hosts of *Paragonimus* in the Orient. The two exceptions to this are *Syncera lutea* A. Adams, 1861 of the family Synceridæ and *Oncomelania nosophora* of the family Ammicolidæ. According to Abbott, *Syncera lutea* was implicated by H. T. Chen in China and *Oncomelania nosophora* was reported by K. C. Chen to harbor *Paragonimus* cercariæ in Foochow, Fukien Province, China.

Abbott's handbook lists three genera of the family Thiaridæ implicated in the life history of *Paragonimus* in the Orient: *Semisulcospira, Hua* and *Thiara.* The genus *Semisulcospira* includes the most important of these intermediate hosts: *Semisulcospira libertina* Gould (=*Melania libertina* Gould) in Japan Korea and Formosa; *Semisulcospira libertina multicincta* von Martens and *Semisulcospira libertina extensa* von Martens in Korea. The genus *Hua* includes the species *Hua* (*Hua*) *amurensis* (= *Melania gottschei* and *Melania nodiperda*), implicated by Kobayashi in Korea, while the genus *Thiara* is represented by the species *Thiara* (*Tarebia*) *granifera* in Formosa. As exemplified by the species *Brotia asperata,* the genus *Brotia* must now be added to the three genera as being of medical importance and involved in the life cycle of *Paragonimus* in the Orient.

Abbott, who has made extensive collections of snails in Leyte Island, Philippines, considers *Brotia asperata* as a reasonably common species which prefers well-oxygenated, fast flowing water in shady areas and which appears to be widely distributed throughout the country, at least on the larger islands. He(19) made the following observations about two streams in eastern Leyte from which he collected this species:

Common in stream —— 3 feet wide, 2 feet deep. Water flow swift, 78° F., pH 7.4. Banks of stream steep, shaded. Bottom of soft sand and mud.

Brook —— 3 feet wide, 1 inch deep; flow rapid; bottom rocky; shaded.

The physical characteristics of the streams in which the snail and crab hosts of *Paragonimus* were found in the present study

correspond well with those of the streams described by Abbott. All six streams where collections were made were mountain streams only a few feet wide and 1 to 2 feet deep in most parts. The water was cool and swift-flowing and so clear that it was being used by the people for drinking. The streams were generally well-shaded, had steep banks and a sandy or rocky bed with big boulders.

SUMMARY

Based on the finding of naturally infected snails and crabs from mountain streams in the Municipality of Casiguran, Sorsogon Province, Luzon Island, the snail *Brotia asperata* Lamarck, 1822 and the crab belonging to *Parathelphusa* (*Barythelphusa*) *grapsoides* species complex were identified as first and second intermediate hosts, respectively, of *Paragonimus* in the Philippines. These findings confirm the species of snail and revise the species of crab previously reported as the intermediate hosts of *Paragonimus* in this country. A brief review of Tubangui's work on the life history of *Paragonimus* in the Philippines and some information on the implicated snail and crab species are given.

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The author is greatly indebted to Dr. R. Tucker Abbott and Dr. Fenner A. Chace, Jr., without whose help this paper could not have been written. Thanks are also due to Dr. Frederik B. Bang and Dr. Clark P. Read of the Johns Hopkins School of Hygiene and Public Health for valuable suggestions made during the preparation of this manuscript.

REFERENCES

1. Musgrave, W. E. Paragonimiasis in the Philippine Islands. Philip. Jour. Sci. §B 2 (1907) 15–66.
2. Nakagawa, K. The mode of infection in pulmonary distomiasis. Jour. Infect. Dis. 18 (1916) 131–142.
3. Nakagawa, K. Further notes on the study of the human lung distome, Paragonimus westermani. Jour. Parasit. 6 (1919) 39–43.
4. Kobayashi, H. On the final and intermediate hosts of lung fluke in Chosen. Far Eastern Ass. Trop. Med. Trans. 6th Biennial Congress, Tokyo. 1 (1925) 413–418.
5. Ying, Y. Y. Paragonimus infestation. A report of two cases. Nat. Med. Jour. China 16 (1930) 638–642.
6. Maxwell, J. L. Paragonimiasis in China. A preliminary report. China Med. Jour. 45 (1931) 43–49.

7. Vogel, H., K. Wu, and J. Y. C. Watt. Preliminary report on the life history of Paragonimus in China. Far Eastern Ass. Trop. Med. Trans. 9th Congress, Nanking 1 (1934) 509–517.
8. Wu, K. Notes on certain larval stages of the lung fluke, Paragonimus, in China. Chin. Med. Jour. 49 (1935) 741–746.
9. Tubangui, M. A. The molluscan intermediate host in the Philippines of the Oriental blood fluke, Schistosoma japonicum Katsurada. Philip. Jour. Sci. 49 (1932) 295–304.
10. Tubangui, M. A., and A. M. Pasco. The life history of the human intestinal fluke, Euparyphium ilocanum (Garrison, 1908). Philip. Jour. Sci. 51 (1933) 581–606.
11. Tubangui M. A. Preliminary report on the specific identity and life history of the lung fluke of mammals (Paragonimus) in the Philippines (Abstract). Abstracts of Scientific Papers Presented before the Conference of Medical Sciences in Commemoration of the Establishment of the Republic of the Philippines, December 20, 21, 22, Manila (1943) 36–37. (As listed in No. 14, below).
12. Tubangui, M. A. Preliminary notes on the crustacean vector of the mammalian lung fluke (Paragonimus) in the Philippines. Jour. Parasit. 32 (1946) 150–151.
13. Tubangui M. A. Correction. Jour. Parasit. 33 (1947) 284.
14. Tubangui, M. A. A summary of the parasitic worms reported from the Philippines. Philip. Jour. Sci. 76 (1947) 225–304.
15. Tubangui, M. A., B. D. Cabrera, and M. G. Yogore, Jr. Studies on the life cycle of the human lung fluke (Paragonimus) in the Philippines: A preliminary report. Acta Med. Phil. 6 (1950) 371–372.
16. Yogore, M. G., Jr., G. A. Noble, and B. D. Cabrera. Studies on paragonimiasis: II. The morphology of some of the larval stages of Paragonimus in the Philippines. Philip. Jour. Sci.. 86 (1957) 47–69.
17. Rathbun, M. J. Les crabs d'eau douce (Potamonidæ). Nouv. Arch. Mus. Hist. Nat. (Paris) 6 (1904) 225–312.
18. Abbott, R. T. Handbook of medically important mollusks of the Orient and the Western Pacific. Bull. Mus. Comp. Zool. 100 (1948) 245–328. Cambridge: Harvard College.
19. Abbott R. T. Personal Communication, 1954.

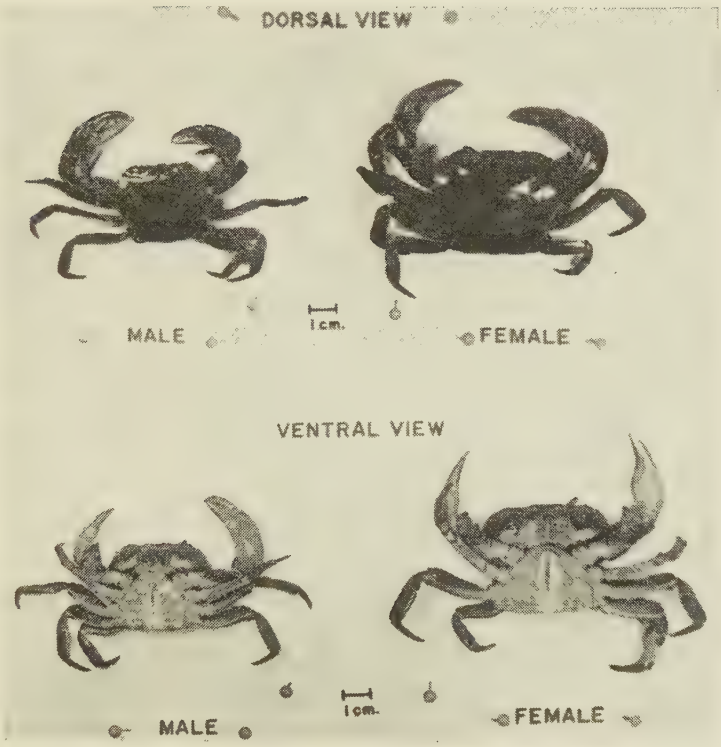
ILLUSTRATIONS

PLATE 1

FIG. 1. First intermediate host: *Brotia asperata* Lamarck, 1822.
2. Second intermediate host: *Parathelphusa* (*Barythelphusa*) *grapsoides* species complex.

1 cm.

1


DORSAL VIEW
MALE
1 cm.
FEMALE
VENTRAL VIEW
MALE
1 cm.
FEMALE

2

PLATE 1.

STUDIES ON PARAGONIMIASIS, II *

THE MORPHOLOGY OF SOME OF THE LARVAL STAGES OF PARAGONIMUS IN THE PHILIPPINES

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FOUR PLATES

INTRODUCTION

Although paragonimiasis has been known to be endemic in the Philippines for almost fifty years, many aspects of the basic biology and life history of *Paragonimus* in this country remain unknown. There is a great inadequacy of information on the morphology of the parasite, especially of its larval stages.

The literature on paragonimiasis in the Philippines contains only one paper which gives an adequate description of the adult parasite. This is Musgrave's report(1) which first showed the endemicity of this disease in this country in 1907 and which was therefore written when much of the knowledge of the morphology of *Paragonimus* from other parts of the world was unpublished. Also, only Musgrave seems to have described the egg of the parasite, although photomicrographs of this stage have appeared in other publication.(2,3) The description of the egg given by Musgrave is inadequate from the standpoint of taxonomy. Thus, even with these two stages of the parasite, a restudy seems to be in order and may be of importance in shedding light on the still unsettled question of the validity of species and of taxonomic bases within the genus *Paragonimus*.

Of the morphology of the larval stages of the parasite, almost nothing has been published. The larval stages of the local *Paragonimus* from the first intermediate host have never

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been described. The only published account of the morphology of the encysted metacercariæ from the second intermediate host is given in one sentence written by Tubangui(4) in 1946: "The snails and prawns were negative, but the crabs were found harboring encysted metacercariæ which are whitish, globular and double-walled, the inner wall measuring 300 to 320 microns in diameter and the outer wall 340 to 400 microns." As emphasized in the first paper of this series,(5) Tubangui first identified the snail and crab hosts of *Paragonimus* in the Philippines. Undoubtedly, he could have described in detail the larval stages from these hosts since he had to recognize the larvæ in order to identify the intermediate hosts; however, his sudden death prevented him from writing down what he knew.

This paper is intended to fill some of the gaps in our knowledge of the morphology of *Paragonimus* found in the Philippines; to take up what Tubangui had to leave off because of his untimely death. It is offered in support of the first paper of this series, in which was reported the identity of the first and second intermediate hosts of *Paragonimus* in this country. These two papers of the series are deemed important, aside from the academic interest that they may hold for the parasitologist, because they can place workers in this country in a position to identify the intermediate hosts and prove them infected with the parasite. The door therefore becomes open to extending our knowledge, on unquestionable basis, of endemic areas in this country and to the proper understanding of the factors involved in the transmission, epidemiology and other public health aspects of the disease in the native situation.

MATERIALS AND METHODS

Paragonimus larval stages described in this paper were obtained from naturally infected snails of the species *Brotia asperata* Lamarck, 1822 and crabs of the species *Parathelphusa* (*Barythelphusa*) *grapsoides*, first and second intermediate hosts, respectively, of the parasite in the Philippines. Collections of these fresh-water snails and crabs were made at intervals in 1954 to 1955 from streams in Barrios Boho and Mabini, Municipality of Casiguran, Sorsogon Province. These collections were brought in the live condition to the Department of Parasitology, Institute of Hygiene, University of the Philippines in Manila for this study.

THE LARVAL STAGES FROM THE SNAIL

The following procedure was used for determining infection of snails with *Paragonimus:* The posterior half of the shell of the snail was crushed with a pestle to expose the digestive gland ("liver"). The digestive gland was then transferred to a Stender dish where it was crushed slightly with forceps in a few drops of water. The preparation was studied under a dissecting microscope (magnification 10 to 45 x). Larval stages of any trematode harbored by the snail were released into the water and could easily be seen.

More than 5,000 snails were examined by the above procedure, and a few individuals were found positive for the second generation rediæ and cercariæ of *Paragonimus.* Teasing of the digestive glands of these positive snails with dissecting needles released great numbers of these larval stages.

The second generation radiæ and cercariæ from the snails were studied in the live condition in 0.4 per cent sodium chloride solution, as recommended by Komiya and Ito.(6) It was found that these stages in this solution remained alive up to 7 days at a temperature of 40 to 44° F in the ordinary refrigerator.

In order to obtain accurate measurements and to study normal relationships of organs, relaxed and relatively immobile cercariæ were needed. Fixation with 10 per cent hot formalin was found unsatisfactory for obtaining relaxed cercariæ, many of these appearing contracted with such fixation. It was discovered that if a drop of a 2 per cent solution of sodium pentobarbital was added to about two drops of the 0.4 per cent sodium chloride solution on a glass slide, the cercariæ in such medium appeared to be well-relaxed after about 10 minutes. The cercariæ would still be alive, as shown by occasional very slight movements, but would usually be quiet enough to allow accurate measurement. Preparations in which a minimum amount of pressure was exerted on the larvæ were obtained by using a relatively thick layer of vaseline placed all around the edge of the glass slip used to cover the cercariæ on the slide. The vaseline not only prevented pressure but also acted as a seal so that drying of the preparation was avoided for several hours.

The study of the excretory system of the cercariæ was made on preparations in 0.4 per cent sodium chloride without the sodium pentobarbital. Flame cells showed up well but the exact pattern and number were difficult to make out.

The normally sluggish second generation rediæ in 0.4 per cent sodium chloride solution were immobile enough to permit accurate measurement and study. As with the cercariæ, distortion due to pressure was avoided by the use of vaseline between the cover slip and the slide.

THE LARVAL STAGE FROM THE CRAB

Obtaining the encysted metacercariæ from the crabs was easy not only because a high proportion of the crab collection was infected but also because the metacercariæ were often harbored in great numbers—up to a few hundred—by the infected crab. Furthermore, the metacercariæ are of a size large enough to be seen by the naked eye so that, after the carapace had been lifted off the body, a simple inspection of the pericardium, heart, and gills of the crab was sufficient to reveal the more heavily infected ones (Plate 1, fig. 1).

The encysted metacercariæ were teased from the tissue (pericardium, heart, gills, and body muscles) of the crab in saline or water by means of dissecting needles. When free of the tissue, they were picked up with a fine pipette under a dissecting microscope (magnification 10 x) and transferred to a small Petri dish containing physiological salt solution.

Excysted metacercariæ were obtained by a method of stimulating excystment suggested to one of us (M. G. Y., Jr.) by Dr. Muneo Yokogawa of the Institute of Public Health, Tokyo, Japan. A small Petri dish containing the encysted metacercariæ in saline was placed in a water bath maintained at a temperature of 40° C. The metacercariæ excysted within a few hours and were then picked up with a fine pipette for transfer to slides. The excysted metacercariæ were observed in the live state in 0.4 per cent sodium chloride solution with and without sodium pentobarbital. Both encysted and excysted forms were studied in cover-slip preparations using slides with shallow concavities so as to prevent pressure-distortion. Some of the excysted forms were fixed with Bouin's solution after relaxation with sodium pentobarbital and were then stained with Delafield's hematoxylin and mounted in balsam for study.

MORPHOLOGICAL OBSERVATIONS

THE SECOND GENERATION REDIA

The second generation redia of *Paragonimus* found in the Philippines is a whitish, cylindrical larva with a bluntly rounded anterior end and a gradually tapering posterior end.

The body may be very slightly curved in some rediæ but markedly curved in others. The posterior end of the body may terminate as a gradually rounded end or as a rather sharp tip or it may sometimes be pinched off subterminally to form a terminal nipplelike structure (Plate 2, fig. 3, inset). The redia is but slightly motile even when freshly obtained from the live infected snail. Great numbers of rediæ are usually recovered from the snail. Measurement of twenty of these live second generation rediæ gave an average body length of 1.139 mm, with a range of 0.696 to 1.332 mm and an average greatest body width of 0.206 mm, with a range of 0.148 to 0.252 mm. Minute spines are found on the body surface around the oral opening and the anterior portion of the body.

The oral opening, which is located at the anterior tip of the body, leads to a strongly muscular pharynx measuring 62.4 μ (52 to 72 μ) in length by 59.1 μ (48 to 72 μ) in width. The gut, which follows the pharynx, contains a brownish-yellow material ingested from the substance of the snail host. The gut measured 0.438 mm (0.281 to 0.592 mm) in length and 63.9 μ (34.5 to 145 μ) in greatest width. For the group of twenty, the gut length averaged 39 per cent of the total body length with a variation of from 28 to 55 per cent distributed as follows: less than 30 per cent, 2; 30 to 39 per cent, 9; 40 to 49 per cent, 7; over 50 per cent, 2. The proportion of the total length of the digestive system (pharynx length plus gut length) to the body length averaged 44 per cent with a variation of from 34 to 63 per cent distributed as follows: 30 to 39 per cent, 5; 40 to 49 per cent, 12; 50 to 59 per cent, 1; over 60 per cent, 2. The gut is narrowest at its beginning and usually attains its greatest width as it ends. The width of the gut varies from one redia to another, probably as a result of differences in the amount of ingested material, the pressure exerted by developing cercariæ within the body of the redia and the angle of presentation to the observer.

The body cavity of the redia is usually filled with active cercariæ and cercarial embryos in all stages of development. The fully mature cercariæ move about actively among the non-motile immature ones. When dissected out and counted, the number of mature cercariæ inside twenty of the larger second generation rediæ ranged from 8 to 18, with an average of 12.

The redia possesses no collar or locomotor appendage. The birth pore is located at one side of the body adjacent to the

pharynx but it is inconspicuous and is noticed usually only when the cercariæ start to leave the redia through it.

Table 1 shows the measurements of the second generation redia of *Paragonimus* found in the Philippines compared to observations made on the same stage of *Paragonimus* from other countries. The proportion of the gut or digestive system

TABLE 1.—*Comparison of the measurements of the second generation rediæ of Paragonimus found in the Philippines with the same stage of Paragonimus in other countries.*

SPECIES	*P. westermani*		*P. westermani*	
COUNTRY	Philippines		Japan	
AUTHOR(s)			Komiya and Ito(6)	
Preparation	Fresh, in 0.4 per cent sodium chloride sol.		Fixed, in 10 per cent hot formalin	
	Average	Range	Average	Range
Body length (mm)	1.139	0.696–1.832	1.024	0.851–1.350
Body width (mm)	0.206	0.148–0.252	0.296	0.249–0.352
Pharynx length (μ)	62.4	51.7–72.4	72.3	62–76
Pharynx width (μ)	59.1	48.3–72.4	73.2	61–100
Gut length (mm)	0.438	0.281–0.592	---	---
Gut width (μ)	63.9	34.5–144.8	---	---
REMARKS (Proportion of gut or digestive system to total body length).	In twenty specimens, the gut length averaged 39 per cent of the total body length with variation of from 28 to 55 per cent. The entire digestive system averaged 44 per cent of the body length with a range of 34 to 63 per cent.		"--- long intestine which occupies about two-thirds of the length of the redia, occasionally extending to its posterior extremity."	

SPECIES	*Paragonimus* sp.		*P. iloktsuenensis*		*P. kellicotti*	
COUNTRY	Chekiang, China		Kwangtung, China		United States	
AUTHOR(s)	Wu(7)		Chen(8)		Ameel(9)	
Preparation	Live		Live		Fixed and mounted	
	Average	Range	Average	Range	Average	Range
Body length (mm)	0.590	0.440–0.740	1.422	0.813–2.043	0.559	0.332–0.819
Body width (mm)	0.140	0.110–0.190	0.257	0.220–0.357	0.139	0.105–0.171
Pharynx length (μ)	34.0	27–41	60.0	---	44.0	36–56
Pharynx width (μ)	39.0	30–46	65.0	---	47.0	40–58
Gut length (mm)	0.320	0.200–0.380	0.213	0.098–0.486	---	0.039–0.089
Gut width (μ)	25.0	14–41	85.0	---	---	22–71
REMARKS (Proportion of gut or digestive system to total body length).	"The gut extends beyond the middle of the body and sometimes approaches the posterior extremity."		"(The gut) --- being one-third to one-nineteenth of the total body length with an average of one-seventh."		"The entire digestive tract is confined to the anterior third or fourth of the body."	

to the body length is included because it is considered of great taxonomic importance.

THE CERCARIA

The mature cercaria from a recently dissected snail, normally emerged from or teased out of the second generation redia, is a very active organism in 0.4 per cent sodium chloride solution. It twists and bends, elongates and contracts. Attached to the substratum, it moves forward in a quite rapid, progressive and directional manner. The progression is accomplished by a "measuring worm" movement, the organism alternately attaching and releasing the oral and ventral suckers as the body successively elongates and attenuates and then shortens and becomes plumper. The cercaria is of the microcercous type and the tail also changes shape as the worm moves, sometimes being definitely much longer than broad and at other times becoming more or less rounded.

When the cercaria is relaxed in the medium containing sodium pentobarbital, it assumes an ellipsoidal shape on ventral view, with the posterior end more bluntly rounded than the anterior which tapers gradually (Plate 2, fig. 5 and Plate 3, fig. 6A). Measurements of 20 relaxed cercariæ showed an average body length of 220 μ, with a range of 199 to 240 μ, and an average greatest width of 78 μ, with a range of 69 to 93 μ. The tail is somewhat longer than wide, measuring 20 μ (14 to 24 μ) in length by 17.3 μ (14 to 21 μ) in width. The body is covered with tiny spines while the tail bears longer (about 4 μ) posteriorly directed spines at its posterior portion.

The relaxed cercaria usually assumes a typical attitude on lateral view. The body is flexed ventrally at a level just anterior to the ventral sucker so that the anterior portion of the body forms an angle with the posterior portion. A lateral view of the cercaria shows another morphological detail not appreciable on ventral view—this is the presence of a ventral folding of the body posterior to the ventral sucker. This fold occurs along the antero-posterior axis at the midline so that a V is formed, the apex being the midline, the two halves of the body from the posterior margin of the ventral sucker to the posterior end forming the limbs of the V, and the edges of the body flaring out in a thickened cuticle at the two ends of the V. Plate 3, figs. 6B and 7 show the cercaria on lateral view, bringing out this morphological detail as well as the attitude of the relaxed organism.

The anterior sub-terminal mouth, which opens ventrally, is surrounded by an oral sucker measuring 52.2 μ (45 to 58 μ) in length by 47.8 μ (41 to 58 μ) in width. A large stylet is embedded in the posterior wall of the oral sucker and is independent of the oral opening. The relationship of the stylet to the oral sucker and oral opening is well seen in the lateral views of the cercaria (Plate 3, figs. 6B and 7). Measured from the ventral aspect, the stylet was 26.1 μ (21 to 29 μ) in length and 7.1 μ (6.9 to 8.6 μ) at its greatest width which is located at a level just anterior to its base. Because of the ventral flexion of the body, the stylet was presented to the observer at an angle, sometimes rather acutely, and the measurement of its length was thereby affected. Therefore, the stylet length was measured in ten cercariæ lying on one side and an average length of 30.2 μ (27.4 to 31.5 μ) was obtained, the figure being greater than the measurement from the ventral view, as expected.

A prepharynx 19.7 μ (10 to 24 μ) long connects the mouth to a small, muscular pharynx 14.6 μ (10 to 21 μ) in length by 13.2 μ (10 to 19 μ) in width. In these specimens, the digestive system could not be followed beyond the pharynx.

The ventral sucker, located just posterior to the center of the body, is smaller than the oral sucker. It measures 34.1 μ (31 to 38 μ) in length by 38.9 μ (34 to 48 μ) in width. Because of the flexure of the body the ventral sucker is presented at an angle to the observer on ventral view just as the stylet is, but measurement of the length of this organ in 10 cercariæ lying on one side showed an increase of only 1.2 μ over that of the measurement taken from the ventral view.

Between the levels of the ventral sucker and the pharynx are seven pairs of penetration gland cells, one of each pair in each half of the body. Each of the body halves has the seven cells divided into two groups; an inner group of three cells located near the midline and seen to lie in a more ventral position on lateral view and an outer group of four cells located lateral and dorsal to the other group. The ducts of the outer group of cells run a wavy course anteriorly and dorsally close to the lateral margin of the body to enter the oral sucker and open just below and dorsal to the tip of the stylet. The ducts of the inner group also run a sinuous course anteriorly, but stay close to the midline to enter the oral sucker and end just posterior to the opening of the outer group.

A mass of germinal cells is located immediately posterior and dorsal to the ventral sucker and anterior to the excretory bladder.

The excretory bladder occupies the midline of the posterior fourth of the body. It is definitely an I-shaped structure as seen in both the ventral and lateral views, although in the ventral view, its anterior portion may be somewhat wider than the posterior. Its length varies greatly as the organism contracts and elongates, but in the relaxed specimen it measures 50.2 μ (41 to 62 μ). The bladder leads posteriorly to a small, short canal which opens at the posterior margin of the body where the tail seems to be attached. From each of the two anterolateral angles of the excretory bladder, an excretory tube arises to run sinuously in an anterior and lateral direction for a short distance until it goes into a series of complicated loops as it reaches the level of the posterior margin of the ventral sucker. From these loops arise two main excretory tubules, one proceeding anteriorly and the other posteriorly. It was not possible to follow the complete course of these two main branches and their ramifications to the flame cell termini, but careful study revealed all the flame cells and their locations. The flame cells total 30 for each half of the body, with 15 of them apparently associated with the anterior main tubule and the other 15 with the posterior one, the groups of fifteen flame cells each being separated one from the other at the level of the junction of the middle and posterior thirds of the ventral sucker. The excretory system of this cercaria, including the flame cell arrangement, is illustrated in Plate 3, fig. 6A.

Table 2 gives the measurements of the cercaria of *Paragonimus* from the Philippines in comparison with the measurement of the cercaria of *Paragonimus* from other countries.

THE METACERCARIA

A. THE ENCYSTED FORM

The encysted metacercaria of *Paragonimus* found in the Philippines is a generally spherical body readily seen with the naked eye when it is set against the background of the pericardial membrane, heart, or gills of the crab. It is the whitish reflection of the contents of its excretory bladder which attracts attention to its presence. Under the microscope, however, the contents of the excretory bladder appear jet-black when seen in thick clumps in the transmitted light and its amount and prominence easily make it the most eye-catching feature of

TABLE 2.—*Comparison of the measurements of the cercariæ of Paragonimus found in the Philippines with the same stage of Paragonimus in other countries.*

[All measurements are expressed in microns.]

SPECIES	*P. westermani*		*P. westermani*		
COUNTRY	Philippines		Japan		
AUTHOR(S)			Komiya and Ito(6)		Yamaguti **
Preparation	Live, in NaCl with pentobarb.		Fixed in 10 per cent hot formalin		Fresh, raw
	Average	Range	Average	Range	Range
Body length	220.0	199–240	270.0	235–314	180–260
Body width	78.0	69–93	99.0	94–116	70–130
Oral sucker length	52.2	45–58	60.4	58–67	42–63
Oral sucker width	47.8	41–58	56.3	49–64	42–63
Ventral sucker length	34.1 *(35.3)	31–38 *(31–41)	31.9	24–37	24–26
Ventral sucker width	38.9	34–48	43.6	43–57	30–38
Stylet length	26.1 *(30.2)	21–29 *(27–32)	33.4	30–37	36
Stylet width	7.1	6.9–8.6	7.5	6–9	9
Prepharynx length	19.7	10–24	19.5	9–37	15–33
Pharynx length	14.6	10–21	15.4	13–18	10–18
Pharynx width	13.2	10–19	16.0	13–18	8–12
Bladder length	50.2	41–62	75.2	73.2–94.5	
Tail length	20.0	14–24	26.6	21–37	15–30
Tail width	17.3	14–21	17.8	12–21	9–17

SPECIES	*Paragonimus* sp.		*P. ilokt-suenensis*	*P. kelli-cotti*
COUNTRY	Chekiang, China		Kwang-tung, China	United States
Author (s)	Wu(7)		Chen(8)	Ameel(10)
Preparation	Live		Live	Fixed in formalin, slightly flattened
	Average	Range	Average	Average
Body length	225	130–310	265	178
Body width	58	36–62	102	93
Oral sucker length	57	36–70	55	48
Oral sucker width	58	48–78	55	
Ventral sucker length	80	15–42	37	47x34
Ventral sucker width	30	15–42	37	
Stylet length	36	28–48	30	39
Stylet width	8	5–10		7
Prepharynx length				
Pharynx length			22	
Pharynx width	15x12		22	
Bladder length				
Tail engtn	19	15–22	23	15
Tail width	13	12–18		14

* Figures in parenthesis give the measurements taken from the lateral view.

** As given by Komiya and Ito.

the organism. When freshly taken from the crab, the metacercaria is seen to move actively inside the cyst wall, shifting its position from time to time and changing in outline as different portions of its body contract and relax.

The encysted metacercaria, as seen after it is teased from the tissue of the crab, usually presents two definite walls: an outer, very delicate membrane separated at a variable distance by a clear space from an inner, thick wall immediately applied to the enclosed organism.

The outer wall is not always seen—it may be broken off during the dissection of some of the encysted metacercariae from the tissues of the crab or it is so closely applied to the inner wall in certain specimens that it cannot be observed. In 6 out of 25 cysts that were measured for this study, this membrane was not evident. The membrane forms more frequently an oval rather than a spherical envelop for the metacercaria; in most instances there is some measurable disparity between two of its diameters: In 19 specimens where the membrane could be seen, three had a perfectly spherical shape while the rest had the membrane in a more oval than spherical shape, with a difference between the greater and lesser diameters varying from 4 to 89 μ, although the variation was so slight in most of these that the disparity was hardly noticeable. The encysted metacercaria, measured from the membrane wall is 359 μ (326 to 414 μ) along its longest diameter and 339 μ (296 to 400 μ) along the shortest diameter.

Within the envelop formed by the membranous wall, the encysted larva is seen enclosed by a usually spherical, thick inner wall which immediately surrounds it. This inner wall forms a sphere much more frequently than does the outer wall; measurement of its diameters along two different axes usually shows no or very slight differences. Of the 25 encysted metacercariæ measured for this study, the inner wall was spherical in ten; in the rest the difference between the longest and shortest diameters ranged only from 4 to 22 μ. The metacercaria measured from the inner wall is 320 μ (296 to 337 μ) in the longest diameter by 313 μ (296 to 326 μ) in the shortest diameter.

The thick inner wall consists of two distinct layers: an outer one which is very dark and homogeneous under the microscope and an inner one, immediately adjacent to the enclosed larva, which appears refractile, with some evidence

of layering and slight radial striations and an apparently not very smooth inner surface. Each layer is usually of uniform thickness all around in any individual cyst, and the outer dark layer is usually thicker than the inner one. The outer layer is 10.5 μ (2.6 to 17.2 μ) thick while the inner layer is only 5.5 μ (3.4 to 13.8 μ). Both layers make up a wall 16.2 μ (6.9 to 25.0 μ) in thickness. The organism inside is better studied after it has excysted.

Table 3 gives the measurements of the encysted metacercariæ of *Paragonimus* in the Philippines in comparison with the same

TABLE 3.—*Comparison of the measurements of the encysted metacercaria of Paragonimus found in the Philippines with the same stage of Paragonimus in other countries.*

[All measurements are expressed in microns.]

SPECIES	*P. westernmani*			*P. kellicotti*		*P. iloktsuenensis*	
COUNTRY	Philippines			U. S. A.		(Kwangtung) China	
AUTHOR			Tubangui (4)	Ameel (9)		Chen (8)	
	Average	Range	Range	Average	Range	Average	Range
Outer wall			340–400	Present, closely adherent to inner cyst wall.		Only one wall	
Greatest diameter	359.0	326–414					
Least diameter	339.0	296–400					
Inner wall			300–320				
Greatest diameter	320.0	296–337		420	381–457	257	214–302
Least diameter	313.0	296–326		406	381–447	216	200–230
Thickness of inner wall	16.2	6.9–25.0			56–57		1–3
Dark, outer layer	10.5	2.6–17.2					
Light, inner layer	5.5	3.4–13.8					

SPECIES	*P. ohirai*		*Paragonimus species*				
COUNTRY	Japan		(Chekiang) China		Formosa	Korea	
AUTHOR	Miyazaki*		Vogel*		Nakagawa*	Kobayashi*	
	Average	Range	Average	Range	Range	Average	Range
Outer wall							
Greatest diameter							
Least diameter							
Inner wall				320–410	300–400		350–470
Greatest diameter	268						
Least diameter	210						
Thickness of inner wall		3–5			10–14	20	
Dark, outer layer							
Light, inner layer							

* As given by Chen

stage of *Paragonimus* in other countries. Plate 3, fig. 8 shows the metacercariæ dissected out of the crab tissues.

B. THE EXCYSTED FORM

The living, newly excysted metacercariæ of *Paragonimus* in the Philippines is an actively motile organism, moving about in a leechlike manner, the worm extending its anterior portion and then drawing the rest of the body after it. This form, however, does not attain the same degree of directional and progressive motility that is exhibited by the cercaria.

The excysted form, either live and relaxed in sodium pentobarbital or fixed and mounted, assumes an ovoidal shape with the greatest width at about the junction of the middle and posterior thirds of the body. The portion of the body anterior to this level tapers very gradually while the posterior portion decreases in width more abruptly, rounding bluntly as it ends. At the midline of the posterior margin of the body, an indentation marking the location of the excretory pore is usually seen. The body is covered with minute spines which are more prominent anteriorly than posteriorly. The organism has a very gently arching body, the concavity formed by the arch being ventral.

Twenty live and relaxed excysted metacercariæ measured 561 μ (444 to 651 μ) in length by 266 μ (252 to 296 μ) in greatest width. A slight contraction of the body evidently results from fixing, staining, and mounting since twenty specimens so treated measured only 507 μ (444 to 548 μ) in length by 250 μ (229 to 266 μ) in greatest width.

The oral sucker is located at the anterior end of the body and surrounds the mouth. In living animals, it is almost circular, measuring 72 μ (69 to 79 μ) in length by 69 μ (68 to 82 μ) in width; in the fixed specimens, it is somewhat broader than long, measuring 57 μ (48 to 62 μ) in length by 65 μ (59 to 72 μ) in width. Embedded in the posterior wall of the oral sucker is a tiny stylet, much less prominent than in the cercaria and apparently more variable in size. In the living preparation, it measured 14 μ (6.8 to 21 μ) in length by 3.4 μ in greatest width; when fixed, it measured 12 μ (7 to 14 μ) in length by 3.4 μ in greatest width.

The dark contents of the excretory bladder obscures the ventral sucker in most of the excysted metacercariæ in the fresh preparation; however, the ventral sucker may very occasionally be seen in those metacercariæ which have discharged the excretory material. In the fixed, stained and mounted specimens,

the bladder contents have disappeared and the ventral sucker is clearly seen. This sucker is found in the midline with the junction of its middle and posterior thirds at the level of the center of the body. It is somewhat larger than the oral sucker, though, like the latter, it is broader than long, measuring 78 μ (69 to 86 μ) in length by 87 μ (79 to 100 μ) in width in the stained specimens.

A small muscular pharynx, measuring 31 μ (27 to 38 μ) in length by 28 μ (21 to 34 μ) in width in the stained material is located very close to the oral sucker. It leads to the oesophagus which is not well seen in stained material. In the living organisms, the œsophagus is seen as a very short tube which changes dimensions as the intestinal cæca lengthen and retract with the elongation and contraction of the whole body. The œsophagus bifurcates to form the intestinal cæca, the bifurcation taking place very much anterior to the ventral sucker at the junction of the anterior and second fourths of the body.

The intestinal cæca extend to the posterior end of the body where they end blindly. Each cæcum makes at least three arcs in its course, the concavity of each arc being directed to the midline. The intestinal cæca are narrowest at the first arc, ranging from 17 to 35 μ in width, and are widest at the end of the second arc or in the third arc where they may reach a width of 72 μ. The first arc is anterior to the ventral sucker while the concavities of the two second arcs partly surround the ventral sucker.

A most prominent feature of the excysted metacercariæ is the long, I-shaped excretory bladder which, in the newly excysted specimen, is filled with a jet-black mass. It ocupies the entire intercaecal area, extending from the bifurcation of the cæca anteriorly down to the posterior end of the body. Posteriorly it narrows to form a canal about 28 μ in length and opens through an excretory pore located at the midline of the posterior margin of the body. When the worm is alive, the contents of the excretory bladder may be seen to pass through this canal and out of the excretory pore in spurts, and the trail of the worm may be marked by this material. The material itself consists of dark greenish, oval or spherical bodies which may range in size up to 3 or 4 μ in diameter.

From each side of the excretory bladder, a little posterior to the ventral sucker, arises a large collecting tubule which runs

a markedly sinuous course in a lateral and slightly anterior direction. At about the level of the posterior margin of the ventral sucker, as each tubule reaches the inner margin of the intestinal cæcum, it receives two branches—one anterior and the other posterior. These two branches, especially the anterior one, can be followed for a considerable distance and may be seen to receive numerous smaller branches but they could not be followed up to the flame cell termini. The pattern of the flame cells could not be made out completely; only 16 flame cells in each half of the body of the excysted metacercariæ were counted, but the number of branches received by the anterior and posterior tubules indicated that there were many more that were not seen.

In the fixed and mounted preparations where the contents of the excretory bladder have been completely removed, groups of cells in the posterior half of the intercæcal area are seen. These groups of cells may represent the primordia of the gonads. Structures which appear as tenuous processes from the wall of the excretory bladder are also present.

Table 4 gives the measurements of the excysted metacercariæ of *Paragonimus* in the Philippines in comparison to the same stage of *Paragonimus* in other countries. Plate 4, figs. 9 and

TABLE 4.—*Comparison of the measurements of the excysted metacercariæ of Paragonimus found in the Philippines with the same stage of Paragonimus in other countries.*

[All measurements are expressed in microns.]

SPECIES	*P. westermani*				*P. ilokt-suenensis*	*P. ohirai*
COUNTRY	Philippines				China	Japan
AUTHOR					Chen(8)	Miyazaki*
Preparation	Live, in NaCl		Fixed and mounted		Live	
	Average	Range	Average	Range	Average	Average
Body length	561.0	444–651	507.0	444–548	313	418
Body width	266.0	252–296	250.0	229–266	199	164
Oral sucker length	72.0	69–79	57.0	48–62	53	52
Oral sucker width	69.0	68–82	65.0	59–72		
Stylet length	14.0	6.8–21	12.0	7–14	11	10
Stylet width	3.4		3.4			
Pharynx length			31.0	27–38		
Pharynx width			28.0	24–34	29	
Ventral sucker length			78.0	69–86	53	
Ventral sucker width			87.0	79–100	54	59

TABLE 4.—*Comparison of the measurements of the excysted metacercariæ of Paragonimus found in the Philippines with the same stage of Paragonimus in other countries.*—Continued

[All measurements are expressed in microns.]

SPECIES	*Paragonimus sp.*			*P. kellicotti*	
COUNTRY	Formosa	Korea		U. S. A.	
AUTHOR	Nakagawa*	Kobayashi*		Ameel(9)	
Preparation		Mounted			
	Range	Average	Range	Average	Range
Body length		650	410–720	623	524–866
Body width		230	150–270	239	209–295
Oral sucker length	80 to 110		56–64 by 70–90		62×67 to 84×84
Stylet length			20–24	13	9–22
Stylet width				4	
Pharynx length					33×36 to 38×38
Ventral sucker length	70 to 120		80–100 by 100–110		67×111 to 103–127

* As given by Chen.

10 are photomicrographs of the excysted metacercaria of *Paragonimus* in the Philippines.

DISCUSSION OF RESULTS

A number of workers, notably Chen and Ameel, have attached great importance to the length of the digestive system of the second generation redia as a differentiating characteristic in the genus *Paragonimus*. In *P. kellicotti*, the entire digestive tract of the second generation redia is confined to the anterior third or fourth of the body; in *P. iloktsuenensis*, it is even shorter, being one-nineteenth to one-third of the total body length. In contrast to these two forms with short guts are *P. westermani* of Japan and *P. ringeri* of other Asiatic countries (Korea, Formosa, and China) which are characterized by relatively long digestive systems, extending to half the body length or even approaching the posterior end of the body in some instances. The digestive tract of the second generation redia of *Paragonimus* from the Philippines has been found to extend to almost half the length of the body in most cases, and may sometimes go beyond this point. Thus, while the gut of the local second generation redia may not be as long in proportion to that in *P. westermani* or *P. ringeri* from other countries, the similarity is marked; on the other hand, its contrast to the digestive tract: body length proportion as found in the

rodent form, *P. iloktsuenensis,* or in the North American form, *P. kellicotti,* is striking.

As far as size is concerned, the second generation redia of the local *Paragonimus* is definitely larger than the corresponding stage of *P. kellicotti* and of *Paragonimus* from Northern China as described by Wu(7) and smaller than that of *P. iloktsuenensis.* It is almost identical in length to that of *P. westerman* in Japan as described by Komiya and Ito,(6) although the Japanese form appears to have a plumper body.

It must be noted, however, that rediæ of the same species vary greatly in size. The rediæ grow considerably after the first cercariæ escape and they are largest when old and partly empty. Furthermore, the percentage of the body length occupied by the intestine may change, becoming less in the older, larger rediæ. These variations may account for the fact that the length of the intestine in relation to total length was less in the rediæ studied here than in measurements made by some authors. The large size of the rediæ measured in this study indicate that these were older ones; on the other hand, the rediæ measured by Wu(7) were small and probably younger, hence the percentage of the body length occupied by the intestine was greater.

Differences in the morphology of the cercaria apparently cannot be used for separating species of *Paragonimus* since, as noted by Chen,(8) "there is a general uniformity of structures, except perhaps the number of ducts of the secretory glands." Even the number of ducts of the secretory glands is not reliable basis because, as Chen adds in referring to a disparity between his count of the ducts in his species and counts made in other species, such disparity "—is unquestionably a matter of observation rather than the existence of actual differences." However, two points may be mentioned here in regard to the observations on the cercaria of *Paragonimus* found in the Philippines.

The first point concerns the ventral folding of the posterior half of the body in the local cercaria. A comparable feature has been observed in the cercaria of *P. westermani* from Japan by Komiya and Ito(6) since they referred to "a pronounced median groove on the ventral side of the hind body, its maximum depth lying immediately behind the ventral sucker and its wall made up of very thick cuticle, stained orange by neutral red." No comparable feature has been described by Chen(8) for the

cercariæ of *P. iloktsuenensis,* nor by Wu(7) for that of *Paragonimus* from Northern China; neither has Ameel(9,10) mentioned a similar observation for the cercaria of *P. kellicotti.* The median groove, however, is present in *P. kellicotti,* and probably in all species of *Paragonimus* cercariæ.(11)

The second point has to do with the excretory system and flame cell pattern. As far as the details of the excretory system of the cercaria of *Paragonimus* in the Philippines could be worked out, the observations we made agree completely with those of Komiya and Ito(6) on the excretory system of the cercaria of *P. westermani* from Japan. As was noted in the morphological description, the excretory tubules could not be followed up to their flame cell termini but 30 flame cells were counted in each body half and the division of the flame cells into an anterior and posterior group of 15 each was noted. The subdivision of each group into threes could not be demonstrated, but the localization of the flame cells seems strongly suggestive of such subdivision. It is therefore, difficult not to accept the flame cell formula 2 [(3+3+3+3+3)+(3+3+3+3+3)] = 60 given by Komiya and Ito(6) for their cercaria as applying to the cercaria of *Paragonimus* in the Philippines was well. The count of 30 flame cells in each half of the local cercaria is at variance with Ameel's count of 31 in the cercaria of *P. kellicotti.* This disparity in flame cell count most probably arises from the difficulty in counting these cells rather than from actual anatomical differences.

The oval shape, the smaller size and the much thinner cyst wall of the encysted metacercariæ of the rodent forms, *P. iloktsuenensis* and *P. ohirai,* distinguish them from the encysted metacercariæ of *Paragonimus* in the Philippines, which are generally spherical, larger and with a thick cyst wall. The encysted metacercaria of *P. kellicotti* also seems to be much different from the encysted metacercaria from this country. According to Ameel,(9) the mature cysts of *P. kellicotti* are oval and the measurements he gave make these cysts definitely larger than those found here. Furthermore, the cyst wall of the *P. kellicotti* encysted metacercaria is about 2 to 3 times thicker than the cyst wall of the encysted metacercaria of *Paragonimus* in the Philippines. In shape and in thickness of the cyst wall as well as in the presence of a delicate outer wall, the encysted metacercariæ from this country are most similar to those of *P. ringeri* in Korea, Formosa and Northern China. The latter, however, apparently attain a larger maximum size.

The excysted metacercariæ of the rodent forms, *P. iloktsuenensis* and *P. ohirai,* are apparently smaller (about 400 μ or less in length and less than 200 μ in greatest width) than those of *P. ringeri, P. kellicotti,* and *Paragonimus* in the Philippines, which have a length of 500 μ or more and a greatest width of more than 200 μ. Such measurements are to be expected on the basis of the size of the encysted metacercariæ.

The differentiation of species in the genus *Paragonimus* is a difficult problem and one about which the last word has yet to be said. After an exhaustive comparison of a great amount of material, Chen(8) stated:

> With all the evidences secured in the present study it seems that valid species of this genus should comprise the following: *P. westermani, P. kellicotti, P. ohirai* and *P. iloktsuenensis.* Available evidences seem to indicate quite strongly that *P. ringeri,* and *P. edwardsi* are synonyms of *P. westermani.*

Cort(11) agrees with Chen in general, but feels uncertain about *P. ohirai* and *P. iloktsuenensis* being separate species.

The views expressed above do not run counter to usage throughout the years in the literature in the Philippines, where the parasite has always been referred to as *P. westermani,* following the example set by Musgrave(1) when he first reported the endemicity of the disease in this country. It must be noted, however, that Musgrave wrote his report many years before the issue of differentiating between *P. westermani, P. ringeri,* and *P. kellicotti,* on the basis of cuticular spines and other characteristics of the adult as well as of the morphology of the eggs, was raised by Ward and Hirsch(12) in 1915.

These observations on the morphology of some of the larval stages of *Paragonimus* in the Philippines demonstrate many similarities to the corresponding stages of either *P. westermani* in Japan or *P. ringeri* from other countries or to both. These similarities are especially distinct in the second generation redia and the encysted metacercaria, whose features are considered to have great taxonomic importance. Furthermore, these observations show marked differences in the features of the local larval stages from those of *P. kellicotti* and *P. ohirai* and *P. iloktsuenensis.* On the basis of larval morphology alone, therefore, the species of *Paragonimus* from the Philippines may be identified with *P. westermani,* since *P. ringeri* and *P. westermani* may be considered one and the same species.

Other aspects of the biology of *Paragonimus,* such as hostal relationships and the length of the pre-patent period, are of

importance in determining relationships between species. Different animals have yet to be fed with the metacercariæ of *Paragonimus* from the Philippines, but the shortest pre-patent period observed among experimentally infected cats was 65 days. This observation again favors the identity of the local *Paragonimus* with *P. westermani,* which requires about three months to develop to maturity in domestic cats while *P. kellicotti* will develop in 39 to 42 days.

There is no evidence, therefore, to show that the species in the Philippines is not *P. westermani.* The evidences that have been gathered in this work strongly support a contention that the Philippine species is *Paragonimus westermani.*

SUMMARY AND CONCLUSIONS

The second generation redia, the cercaria and the metacercaria, both encysted and excysted, of *Paragonimus* in the Philippines are described in detail for the first time. These larvæ were obtained from naturally infected intermediate hosts from Sorsogon Province, Luzon Island.

The second generation redia averages 1.14 mm in length by 0.21 mm in width. Its size, therefore, approximates that of this stage of *P. westermani* in Japan as described by Komiya and Ito. It is about twice as large as the corresponding stage of *P. kellicotti* in the United States as reported by Ameel and of *Paragonimus* species in Chekiang, China, as observed by Wu. It is somewhat smaller than the corresponding stage of *P. iloktsuenensis* in Kwangtung, China as described by Chen.

The length of the digestive system of the second generation redia of *Paragonimus* in the Philippines is usually just short of one-half of the body length, although the gut may be less than a third of the body length or it may extend to well beyond the middle of the body. The digestive system: body length ratio in this redia is therefore comparable to that of the corresponding stage of *P. westermani* in Japan and of *Paragonimus* species in Chekiang, China, which have relatively long guts. It is certainly different from that found in *P. iloktsuenensis* or *P. kellicotti* in which the digestive system is confined to no more than the anterior third of the body of the second generation redia.

The morphology of the cercaria is apparently not useful for differentiating between species of *Paragonimus.* Two features of the cercaria of *Paragonimus* in the Philippines which may be pointed out are: (*1*) the presence of 30 flame cells, divided

into an anterior group of 15 and a posterior group of the same number, in each body half, and (*2*) the presence of a ventral folding along the antero-posterior axis of the posterior half of the body, seen only when the organism is lying on its side. The first feature makes it likely that the flame cell formula 2 [(3+3+3+3+3) + (3+3+3+3+3)]=60 given for the cercaria of *P. westermani* by Komiya and Ito applies also to this cercaria. This observation is at variance with the 31 flame cell counted in each body half of *P. kellicotti* by Ameel. The second feature finds a similarity in the "median groove" described also for *P. westermani* by Komiya and Ito.

The encysted metacercaria of *Paragonimus* in the Philippines is usually spherical, with an outer membranous and an inner thick wall. It measures about 340 to 360 μ in diameter from the outer wall, and 310 to 320 μ in diameter from the inner wall. It is most similar to the metacercaria of *P. ringeri* from Korea, Formosa and Northern China (as cited by Chen) in shape, thickness of the inner cyst wall, as well as in the presence of the delicate outer wall. Moreover, it has a similarity in size to the metacercaria of *P. ringeri* although the metacercaria of the latter may attain larger sizes. It is different from the metacercaria of the rodent forms, *P. iloktsuenensis* or *P. ohirai*, which is distinctly smaller, oval and with a much thinner cyst wall. It is also different from the metacercaria of *P. kellicotti* which is oval, much larger and with a cyst wall two to three times thicker. As is to be expected from the similarity in size of the encysted forms, the excysted metacercaria of *Paragonimus* in the Philippines is of the same size order as those of *P. ringeri* and *P. kellicotti*. It is larger than the excysted metacercaria of the rodent forms.

If the opinion of Chen is correct that, under the genus *Paragonimus*, only the species *P. westermani, P. kellicotti, P. ohirai,* and *P. iloktsuenensis* are valid, with *P. ringeri* being a synonym of *P. westermani,* then the evidence obtained in this study, especially on the basis of the morphology of the second generation redia and the encysted metacercaria, strongly favor the conclusion that the species of *Paragonimus* in the Philippines is *P. westermani.*

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REFERENCES

1. Musgrave, W. E. Paragonimiasis in the Philippine Islands. Philip. Jour. Sci. §B 2 (1907) 15–16.
2. Vitug, W., and J. R. Cruz. A case of endemic hemoptysis (Pulmonary paragonimiasis). Bull. Quezon Inst. 1 (1941) 289–398.
3. Hasselmann, C. M. Paragonimus westermanii. Case report with microphotograph of operculum of the ovum sprung open. Philip. Jour. Sci. 74 (1941) 285–287.
4. Tubangui, M. A. Preliminary notes on the crustacean vector of the mammalian lung fluke (Paragonimus) in the Philippines. Jour. Parasit. 32 (1946) 150–151.
5. Yogore, M. G., Jr. Studies on paragonimiasis: I. The molluscan and crustacean hosts of Paragonimus in the Philippines. Philip. Jour. Sci. 86 (1957) 37–44.
6. Komiya, Y., and J. Ito. Contribution to the morphology of Paragonimus westermanii. Japan Med. Jour. 3 (1950) 309–314.
7. Wu, K. Notes on certain larval stages of the lung fluke, Paragonimus in China. Chinese Med. Jour. 49 (1935) 741–746.
8. Chen, H. T. Morphological and developmental studies of Paragonimus iloktsuenensis with some remarks on other species of the Genus (Trematoda: Troglotrematidæ). Lignan Sci. Jour. 19 (1940) 429–530.
9. Ameel, D. J. Paragonimus, its life history and distribution in North America and its taxonomy (Trematoda: Troglotrematidæ). Amer. Jour. Hyg. 19 (1934) 279–317.
10. Ameel, D. J. Life history of the North American lung fluke of mammals. Jour. Parasit. 18 (1932) 264–268.
11. Cort, W. W. Personal Communication, 1955–1956.
12. Ward, H. B., and E. F. Hirsch. The species of Paragonimus and their differentiation. Ann. Trop. Med. and Parasit. 9 (1915) 109–162.

ILLUSTRATIONS

Plate 1

Fig. 1. Infected *Parathelphusa* (*Barythelphusa*) *grapsoides* opened to show the great number of *Paragonimus* metacercariæ in its tissues. Arrows point to metacercariæ in gills, heart, and pericardium.

2. Second generation rediæ of *Paragonimus* in the Philippines.

Plate 2

Fig. 3. Camera lucida tracings of the second generation rediæ. Inset shows different posterior ends.

4. Low power view of several cercariæ of *Paragonimus*, relaxed in a medium of 0.4 per cent NaCl sol. with sodium pentobarbital.

5. The cercaria of *Paragonimus* in the Philippines. Ventral view.

Plate 3

Fig. 6. Drawing of the cercaria, made with the aid of camera lucida. Ventral and lateral views. (St, stylet; *OS*, oral sucker; *FC*, flame cell: *Ph*, pharynx; *PG*, penetration gland cells; *VS*, ventral sucker; *GC*, germinal cells; *EB*, excretory bladder; *Ta*, tail).

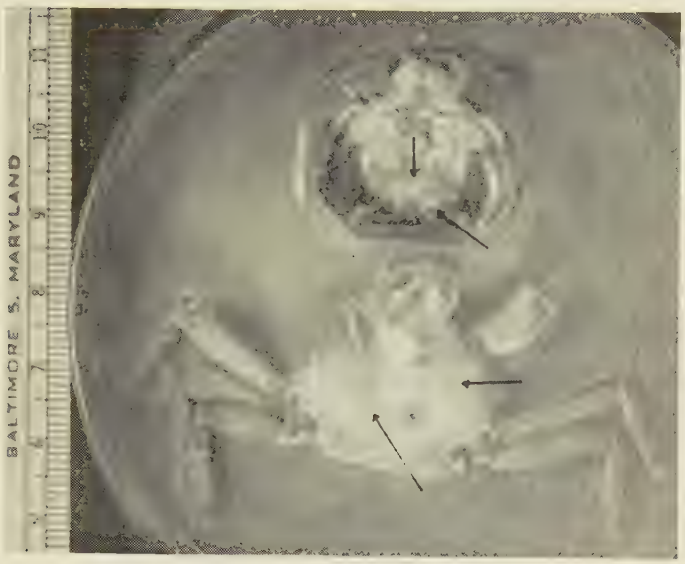
7. The cercaria on lateral view. Note the attitude of the relaxed cercaria, the relationship of the oral stylet to the mouth, and the ventral folding of the posterior half of the body.

8. Encysted metacercariæ dissected from crab tissue. Note the outer membranous wall in three of the cycts.

Plate 4

Fig. 9. The excysted metacercaria. (Live specimen).

10. The excysted metacercaria. (Fixed and mounted).



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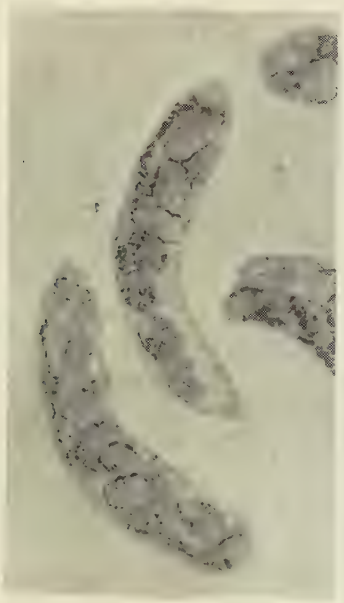

2

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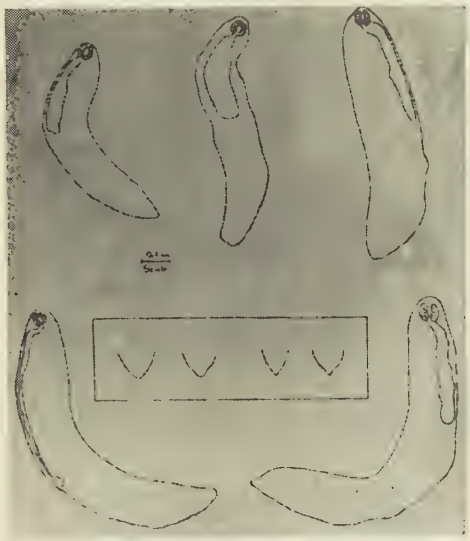

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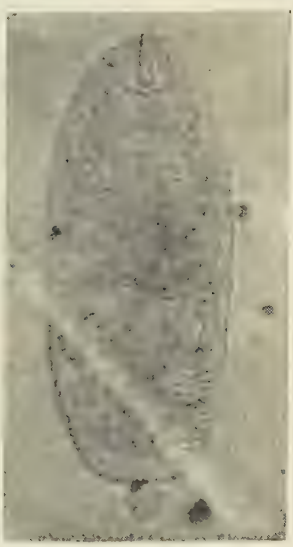

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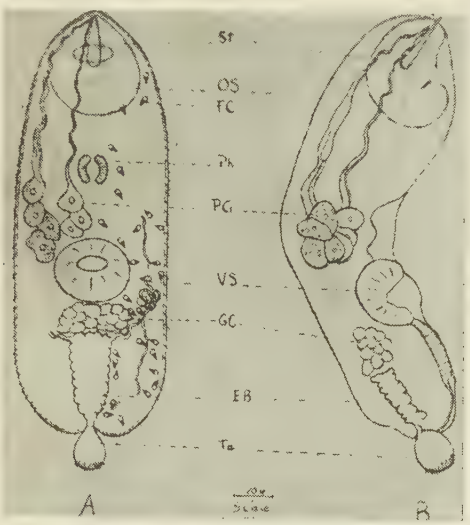

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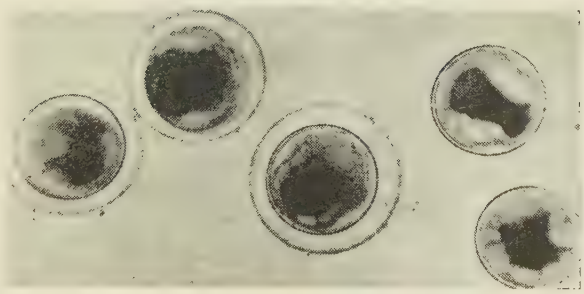

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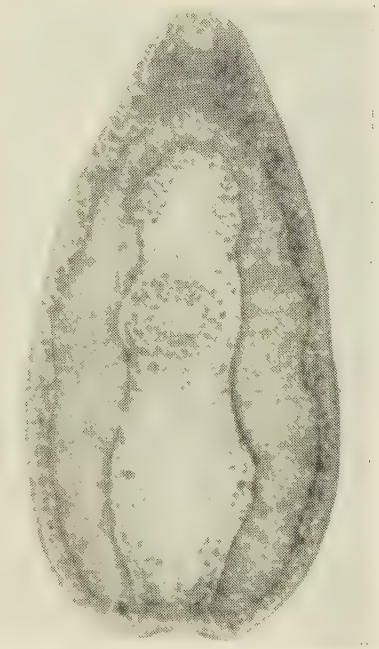
PLATE 3.

9



10

PLATE 4.

NOTES ON PHILIPPINE MOSQUITOES, XIX

THE MOSQUITO PROBLEM IN THE CONTROL OF FILARIASIS IN SORSOGON PROVINCE

By F. E. Baisas

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Three consecutive yearly spraying of DDT in houses seems to have completely cut out the transmission of malaria in Sorsogon Province. No new cases of malaria were encountered during 1955; there was no infant infection whatsoever; and no *flavirostris* was found with oocysts or sporozoites among those dissected for both malaria and filaria infections.

But the transmission of filaria has apparently been going on, perhaps as intensely as in the days before the DDT-house-spraying program. For, microfilaria-positive mosquitoes (some in the infective stage) were repeatedly caught in houses already treated with this insecticide three times. Thus in Barrio Putiao the houses of which (being part of the Index Area of the Southern Bicol Malaria Unit) were specially well sprayed, over 2,000 mosquitoes were caught inside the houses during the Filariasis Survey undertaken in Sorsogon Province by the Institute of Malariology, Department of Health, in June to August, 1956. Of these 1,613 were dissected, representing 1 *Aedes albopictus,* 2 *Aedes poicilius,* 1 *Armigeres obturbans,* 1,394 *Culex fatigans,* 9 *Culex fuscocephalus,* 1 *Culex fuscanus,* 1 *Culex gelidus,* 2 *Culex incognitus,* and 2 *Culex summorosus* (*tritæniorhynchus*). Found positive were: 1 *Aedes poicilius,* 194 *Culex fatigans,* and 3 *Culex fuscocephalus.* 21 *Culex fatigans* had the infective third stage microfilaria larvæ. Many mosquitoes were also caught in other parts of the province where houses were not treated with any insecticide, as well as in houses sprayed with DDT. The total dissections made during the Filariasis Survey was:

TABLE 1.—*Summary of mosquito dissections in Sorsogon Province from June, 1956 to August 31, 1956.*

Mosquitoes	Dissected			Infective	
Species	Number	Positive	Per cent	Number	Per cent
1. *Aedes aegypti*	3				
2. *albopictus*	30	1	3.33		
3. *lineatopennis*	1				
4. *meronephada*	32				
5. *nubicolus*	1				
6. *nocturivus*	3				
7. *pampangensis*	1				
8. *poicilius*	33	4	12.12	2	6.06
9. *Anopheles annularis*	1				
10. *barbirostris*	7				
11. *filipinae*	1				
12. *flavirostris*	3				
13. *indefinitus*	8				
14. *lesteri*	1				
15. *limosus*	6				
16. *maculatus*	2				
17. *peditaeniatus*	1				
18. *pseudobarbirostris*	5				
19. *tessellatus*	1				
20. *Armigeres obturbans*	30	2	6.67		
21. *Culex bitaeniorhynchus*	9				
22. *fatigans*	2,425	231	9.53	33	1.36
23. *fuscatus*	2				
24. *fuscocephalus*	19	6	31.59		
25. *gelidus*	11	1	3.45		
26. *incognitus*	29				
27. *summorosus*	161	10	6.21		
28. *whitmorei*	1				
29. *Mansonia annulifera*	2				
30. *uniformis*	74	1	31.51		
Total	2,903	255	8.72	35	1.12

While the Director of the Institute of Malariology was seeking ways and means to establish a Filaria Control Pilot Project in Sorsogon Province, catching and dissecting of mosquitoes from houses not treated with DDT as well as from sprayed houses were continued. Considerable additional information (not included in this paper) has already been obtained since the termination of the preliminary filariasis survey.

97 Sample specimens from a carabao-baited mosquito trap at Barrio San Jose, Pilar, (a part of the Malaria Index Area) were also dissected, as follows:

TABLE 2.—*Dissections of mosquitoes caught in San Jose carabao-baited trap Sorsogon Province, June, 1956.*

Species	Total dissected	Positive		Infective	
		Number	Per cent	Number	Per cent
Aedes aegypti	2				
lineatopennis	3				
poicilius	1				
vexans nocturnus	2				
Anopheles filipinae	1				
Armigeres obturbans	6				
Culex bitaeniorhynchus	1				
fatigans	19	4	22.22		
fuscocephalus	5				
gelidus	5				
incognitus	4				
summorosus	47	4	8.51	2	4.25
Mansonia uniformis	1				
Total	97	8	8.25	2	2.06

NOTE: Mosquito catches from this trap totalled hundreds a night, but only a few were taken for dissections.

As a result of these findings, a number of things readily come to mind, viz: (*1*) that DDT sprayed in houses is evidently ineffective to cut out filaria transmission;[1] (*2*) that the filaria vectors, like the local malaria vectors, are apparently not exclusively human biters; and (*3*) that as such there seems some probability that the microfilaria infections found in mosquitoes may, in part at least, be from animal reservoirs.

Investigations of filaria infections among domestic and wild animals in Sorsogon Province will be undertaken as soon as the Filaria Pilot Project is fully organized and manned. Edeson & Wharton[2] report, in corroboration to previous findings of Poynton & Hodgkin,[3] microfilaria larvæ in monkey (*Macaca erus*), which are not morphologically differentiable from *W. malayi.* In addition Edeson & Wharton (*loc. cit.*) found apparently the same kind of microfilaria in slow loris (*Nycticebus coucang*), banded leaf-monkey, *Presbytis melalophos,* the domestic dog and the domestic cat.

Dogs and cats and other animals in Sorsogon may harbor similar organisms. But it seems quite reasonable to assume, however, that most, if not all microfilaria infections detected in mosquitoes caught in houses of Sorsogon Province were from human reservoirs because of the high infections among the inhabitants of the areas surveyed (see Table 3 below).

[1] The author was a personal witness to the numerous occasions in the various places surveyed, where mosquitoes, specially *fatigans,* were caught in houses while resting on surfaces where DDT particles were readily visible. These mosquitoes were air-shipped to Manila, then sent by motor car to Tala for dissections. Most of them survived the trip and remained alive 1 to 5 days in a refrigerator at Tala.

[2] Edeson, J. F. B., and R. H. Wharton. Filarial parasites, resembling *Wuchereria malayi,* in domestic and forest animals in Malaya. Trans. Roy. Soc. Trop. Med. Hyg. 49 (1955) 604–605.

[3] Poynton, J. O., and E. P. Hodgkin. Trans. Roy. Soc. Trop. Med. Hyg. 32 (1939) 555.

TABLE 3.—*Filariasis survey in Sorsogon Province.*

[Distribution of positive human beings and mosquitoes.]

Localities	Date surveyed 1956	Total blood smears	Positive blood smears	Per cent Positive	Estimated population	Mosquitoes dissected			Infective		
						Species	Number	Positive	Per cent	Number	Per cent
BARCELONA											
Bangate	July 12	75	10	13.33	130	*A. annularis*	1				
Layog	12	146	14	9.58	540	*Culex fatigans*	48				
Macabarri	12	145	10	6.89	550	*gelidus*	1				
Paghaluban	13	244	9	3.69	582	*summorosus*	1				
Total		610	43	7.05	1,802	(4 species)	51				
BULUSAN											
Poblacion	July 6	594	46	7.58	4,211	*Aedes albopictus*	11	1	9.09		
Buhang (Sn. Vicente)	9	150	5	3.30	1,412	*poicilius*	2				
Dancalan	7	132	23	17.42	400	*Culex fatigans*	15	2	13.33	1	6.66
Purog	9	103	13	12.62	200	*incognitos*	1				
Santa Barbara	10	85	17	20.00	989	*Mansonia uniformis*	2				
San Francisco	11	104	10	9.61	788						
San Isidro	10	175	30	17.14	1,545						
San Jose	11	73	22	30.13	700						
San Rafael	11	102	17	16.66	300						
San Roque	10	91	4	4.40	1,010						
Total		1,609	187	11.62	11,555	(5 species)	31	3	9.68	1	3.23

CASIGURAN											
Banawang	June 27	52	14	26.92	220	*Aedes albopictus*	2				
Boton and Cagdagat	July 26	183	12	6.55	1,410	*meronephada*	1				
Casay	June 28	74	10	13.51	250	*poicilius*	2				
Escuala	28	53	9	16.98	150	*vexans nocturnus*	1				
Inlagadian	29	76	17	22.36	375	*Anopheles barbirostris*	1				
Mabini	27	76	12	15.79	380	*filipinæ*	1				
Rizal	July 27	73	3	4.11	750	*pseudo-barbirostris*	1				
						vagus limosus	1				
San Juan	28	127	14	11.02	645	*Armigeres obturbans*	1				
Trece Martires	26	184	5	2.72	865	*Culex bitaeniorhynchus*	1				
						fatigans	12				
						gelidus	1				
						summorosus	8				
						Mansonia annulifera	1				
						uniformis	1				
Total		898	96	10.69	5,045	(15 species)	35				
GUBAT (mixed places)	June 8	62	10	18.07							
Ariman	29	86	1	1.16	348	*Aedes albopictus*	5				
Bagacay	July 16	206	10	4.85	1,975	*meronephada*	20				
Benguet	3	48	5	10.41	417	*pampangensis*	1				
Bentuco	June 19	81	16	20.00	1,518	*poicilius*	16	3	18.75	1	6.25
Bereran	30	64	5	7.81	298	*Anopheles barbirostris*	5				
Buenavista	July 7	80	6	7.50	421	*flavirostris*	1				
Bulacao	June 19	31	1	3.20	2,036	*indefinitus*	3				
Carriedo	July 7	70	2	2.86	995	*lesteri*	1				
Cogon	13	52	0	0	387	*peditaeniatus*	1				
Jupi	14	38	7	18.42	1,215	*pseudobarbirostris*	4				
Malinao	17	120	13	10.83	367	*tessellatus*	1				
Naagtan	June 29	92	10	10.87	328	*vagus limosus*	2				
Paco	July 17	162	32	19.75	872	*Armigeres obturbans*	2				
Payawin	17	62	15	24.19	1,214	*Culex bitaeniorhynchus*	2				
Rizal	July 7	158	11	6.96	2,030	*fatigans*	288	14	4.86	4	1.39
San Ignacio	July 7	142	5	3.52	553	*fuscocephalus*	1	1	100.00		
Sangat	July 3	108	14	12.96	347	*gelidus*	3				
Santa Ana	June 30	85	24	28.25	894	*incognitos*	15				
Tabe	July 2	236	21	8.89	1,149	*summorosus*	42	3	7.14		
Tagaytay	25	88	9	10.23	491	*Mansonia uniformis*	24	1	4.17		
Teres	16	72	7	9.72	835						
Tugawi	3	63	17	26.98	792						
Union	2	67	10	14.92	798						
Villareal	2	51	10	19.60	558						
Total		2,303	261	11.10	20,838	(20 species)	437	22	5.03	5	1.14

TABLE 3.—*Filariasis survey in Sorsogon Province*—Continued.

[Distribution of positive human beings and mosquitoes.]

Localities	Date surveyed 1956	Total blood smears	Positive blood smears	Per cent positive	Estimated population	Mosquitoes dissected				Infective	
						Species	Number	Positive	Per cent	Number	Per cent
IROSIN											
Poblacion	Aug. 9 and 13	836	40	4.79	7,395	*Aedes albopictus*	2				
						poicilius	1				
Batang	9	78	4	5.13	1,175	*meronephada*	8				
Bolos	June 26	37	9	24.32	140	*Anopheles barbirostris*	1				
Buenavista	Aug. 6	60	4	6.67	1,290	*flavirostris*	1				
Carriedo/Cavite	6	100	5	5.00	652	*indefinitus*	4				
Cassini	6	91	4	4.40	516	*limosus*	1				
Cogon	June 26	88	9	10.22	258	*Culex bitaeniorhynchus*	2				
Gabao	Aug. 3 and 4	332	28	8.43	1,999	*fatigans*	168	5	2.96	4	2.37
						fuscanus	1				
Gulang-gulang and Magon	June 26	92	15	16.30	571	*fuscocephalus*	4	2	50.00		
Lambon	July 30	85	4	4.71	442	*gelidus*	4				
Macawayan	31	185	7	3.78	254	*incognitus*	9	1	11.11		
Mambon	June 25	188	11	5.85	1,642	*sumorosus*	81	7	8.64		
Patag and Mapaso	July 30	299	42	14.09	1,730	*whitmorei*	1				
Salvacion	Aug. 6	89	16	17.98	400	*Mansonia uniformis*	15	3	20.00		
San Benon	3	29	1	3.45	131						
Tabon-tabon	8	48	7	14.58	320						
Total		2,537	206	8.08	18,399	(16 species)	303	18	5.94	4	1.32
JUBAN											
Poblacion	June 12 and 13	243	11	4.53		*Aedes aegypti*	3				
						albopictus	7				
Binanwahan	28	67	3	4.47		*poicilius*	10	1	10.00	1	10.00
Capilihan	28	20	8	40.00	4,287	*lineatopennis*	1				
Cogon	28	66	14	21.21		*nubiculos*	1				
Tughan	28	62	2	3.22		*vexans nocturnus*	2				
						Anopheles flavirostris	1				

Aniog	15	101	20	19.80	500	*limosus*	1						
Puting Sapa	18	48	7	14.58		*maculatus*	2						
Aroroy	22	70	15	21.42	200	*Armigeres obturbans*	27		2	7.41			
Bavolod	21	132	14	10.60		*Culex bitae nigrinychus*	4						
Mapili	21	120	11	9.16	800	*fatigans*	194		5	2.58			
Sangcayon	19	75	22	29.33		*fuscocephalus*	5						
						gelidus	1						
Biriran	13	100	17	17.00	1,064	*vecognitus*	1						
Pulangduta	14	50	3	6.00		*summorosus*	27						
Buraburan	19	48	9	18.75	300	*Mansonia uniformis*	36						
Busay	15	54	7	12.96	300								
Caruhayon	15	78	11	14.10									
Catanagan	15	104	10	9.61	400								
Gurayan	18	125	13	10.40	1,218								
Ilawood	28	47	0	0	300								
Jagusara	18	89	26	29.21	300								
Kalateo	20	56	9	16.07	300								
Mang-og	18	99	13	13.13	300								
Tabok	27	94	9	9.57	400								
Talinga	22	66	11	16.66	150								
Tublijon	20	64	11	25.00									
Rangas	21	35	6	17.14	500								
Sapaya	20	80	4	5.00									
Total		2,193	286	13.04	11,319	(17 species)	323		8	2.43	1	0.31	
PILAR													
Putiao	June 25	148	13	8.78	1,117	*Aedes albopictus*	1		1	50.00	1	50.00	
						poicilius	2						
		Includes catches from Barrio San Jose. Barrio San Jose and Barrio Putiao are parts of the Index Area of the "Southern Bicol Malaria Control Unit."				*Armigeres obturbans*	1						
						Culex fatigans	1,594		194	12.17	21	1.32	
						fuscocephalus	9		3	3.33			
						fuscanus	1						
						gelidus	1						
						inrognitus	2						
						summorosus	2						
Total		148	13	8.78	1,117	(9 species)	1,613		198	12.27	22	1.36	

TABLE 3.—*Filariasis Survey in Sorsogon Province*—Continued.

[Distribution of positive human beings and mosquitoes.]

Localities	Date surveyed 1956	Total blood smears	Positive blood smears	Per cent positive	Estimated population	Mosquitoes dissected				Infective	
						Species	Number	Positive	Per cent	Number	Per cent
PRIETO DIAZ											
Poblacion	July 18	410	24	5.85	2,206	*Aedes albopictus*	2				
Binontolan	24	69	7	10.15	336	*meroenphada*	3				
Bolawan	20	96	2	2.08		*poicilius*	2				
Cagbulalacao	19	61	14	22.95	203	*Anopheles indefinitus*	1				
Calao	24	174	8	4.59	812	*limosus*	1				
Carayat	26	78	17	21.79	135	*Culex fatigans*	75	1	1.33		
Cayo	20	214	18	8.41	553	*incognitus*	1				
Cogon	19	104	5	4.80	490	*summorosus*	7				
Lupi	18	145	10	6.89	483	*M. annulifera*	2				
Manao		41	6	14.63	371						
Manlabong	19	124	15	12.09	623						
Pigtaclaan	24	129	0	0	518						
Quidolog	18	171	6	3.51	616						
Visitang Daan	20	136	18	13.24	385						
Total		1,952	150	7.74	7,731	(9 species)	94	1	1.06		
A. MAGDALENA											
Poblacion	May 21	194	17	8.76	2,725	*Culex fatigans* (all from Poblacion)	31	10	32.36	3	9.68
Salvacion	22	119	36	30.25	1,080						
San Sebastian	23	97	26	26.80	768						
Total		410	79	19.27	4,573		31	10	32.36	3	9.68

During the preliminary filariasis survey, the number of dogs, cats, and other domestic animals seen seemed to be less than what are commonly met in the provinces around Manila. Actually, the writer did not see any monkey on the loose or captured in these places, unlike in other areas, such as the frontiers of Mindanao, or the Cagayan Valley, Luzon, where monkeys are quite often seen.

Nobody seems to have found or reported microfilaria infections among local carabaos. Paul F. Russell did try to find malaria parasites in carabao blood, and if diurnal microfilaria larvæ were present they could have been detected by him. However, no night collection of blood smears from carabaos was done by him, since his studies then were about malaria.

Sometime in 1955, that is, after the second year of DDT spraying in Sorsogon Province, Rozeboom and Cabrera failed to find any mosquito, including *fatigans*, in houses they inspected in Sorsogon. Rozeboom[4] states (p. 5):

> In all the barrios surveyed by us, DDT residual spray had effectively eliminated mosquitoes from houses.

And on p. 8, he continues:

> At the present time the DDT program appears to have practically eliminated *C. fatigans* from the houses in the endemic communities in the Bicol Region; at least we were unable to find them in houses, and we did not have an opportunity to determine whether they were biting people out of doors in the vicinity of houses ..... We do not feel that the vector role of *C. fatigans* has been settled, but if, as seems probable, *C. fatigans* is not involved in extensive filaria transmission in the Philippines, it is not because of its unsuitability as a host for the parasites.

Rozeboom's impression that DDT residual spray had effectively eliminated mosquitoes from houses in Sorsogon is carried in the revised published paper,[5] wherein the following important information is given:

> The results of the experimental infections of the Manila and Sorsogon strains of *Culex fatigans* are summarized in Table 5. There was no real

[4] Rozeboom, L. E. Final Report Concerning Exchange Professorship, Institute of Hygiene, University of the Philippines, for the Academic Year 1954 to 1955. Mimeographed copies, 11 pages, exclusive of four tables, Manila (Institute of Hygiene), 1955. (Distributed to friends, students, etc. by Prof. Rozeboom).

[5] Rozeboom, L. E., and B. D. Cabrera. Filariasis in the Philippine Islands. Amer. Jour. Hyg. **63** (1956) 140–149.

difference between the two strains as hosts of *W. bancrofti.* Only about a third of the mosquitoes supported growth of the larvæ to the infective stage. Most of these insects contained only one or two infective larvæ. The greatest number found in one mosquito was 15. Infective larvæ were found in the abdomen as well as in the proboscis, head and thorax.

Our first impression of the strain of *Culex fatigans* which we obtained from Sorsogon was that it indeed was different from the Manila strain. It was only after 2 or 3 generations of laboratory rearing (in the Institute of Hygiene and Public Health at Manila) that the former would feed readily upon man. However, both Sorsogon and Manila strains were rather indifferent hosts for the Philippine periodic *Wuchereria bancrofti.* Our inability to find authochtonous cases of filariasis in Manila lends support to the view that *C. fatigans* is not a vector. This species becomes extremely abundant and troublesome in the city and its suburbs during certain times of the year.

Our experiences in Sorsogon and in many other parts of the Philippines with regard to *fatigans* do not agree with the statement made by Rozeboom (quoted above), viz: the elimination of *fatigans* by DDT sprayed in houses. In many instances, *fatigans* was the first mosquito caught (after spraying) in houses under observation in Index Areas of different Malaria Units throughout the Philippines. It was several times found within 24 hours after spraying houses with DDT (Baisas, 1956); but more so after the second and third annual spraying than after the first.

Very likely Rozeboom and Cabrera inspected houses in Sorsogon which were naturally unattractive to mosquitoes, whether these houses were treated with insecticide or not. There are many such houses throughout the Philippines. Or else, they might have made their inspections in sections of Sorsogon Province where mosquitoes of all kinds were very difficult to find in houses during the day.

When the author was in Sorsogon Province, directing the mosquito investigations of the Filaria Survey Team, sample catching of mosquitoes in houses of some of the most filarious communities was undertaken. Houses already treated with DDT for three consecutive years, and houses never sprayed with insecticide were carefully inspected. Part of these are shown in Table 4 below:

TABLE 4.—*Daytime sample catching of mosquitoes in houses, Sorsogon Province.*

Date of catching (1956)	Houses inspected: Number of negative houses	Houses inspected: Number of positive houses	Houses inspected: Total houses inspected	Species caught	Male	Female: Condition of abdomen: Blooded	Female: Condition of abdomen: Gravid	Female: Condition of abdomen: Empty	Female: Condition of abdomen: Total ♀♀	Total caught	Range and average of catches per house: Minimum	Range and average of catches per house: Maximum	Range and average of catches per house: Average
Sta. Magdalena (Poblacion) DDT-treated area. Three years of spraying. Last spraying February, 1956.													
May 22	1	9	10	*Culex fatigans*	24	17	7	2	26	50	1	13	5.56
NOTE: The negative house was sprayed with DDT only on March 23, 1954, the owner refused spraying since then; one positive house was sprayed on March 23, 1954; again on April 15, 1955, but owner refused spraying in 1956.													
Caught from this house				*Culex fatigans*	9	2	5	1	8	17			
Bacon (Poblacion) DDT-sprayed area. Three years spraying.													
May 23		2	2	*Culex fatigans*	25	31	15	5	51	76	11	40	38.00
Juban (Poblacion) Houses not sprayed with any insecticide.													
June 12	3	24	27	*Aedes policilius*		2			2	2	0	1	0.074
				Anopheles annularis		1			1	1	0	1	0.037
				barbirostris		1			1	1	0	1	0.037
				flavirostris	1					1	0	1	0.037
				tessellatus		3			3	3	1	2	0.111
				Culex bitaeniorhynchus		1			1	1	0	1	0.037
				fatigans	33	58	41	8	107	140	1	25	5.19
				summorosus		6	2	1	9	9	0	3	0.33
				Mansonia uniformis		2			2	2	0	2	0.074
Total					34	74	43	9	126	160			
Barrio Bereran and Barrio Catanagan, Juban: Houses not treated with DDT.													
June 14	5	8	13	*Anopheles vagus limosus*	1	1			1	2	0	1	0.154
				Culex bitaeniorhynchus		1			1	1	0	1	0.154
				fatigans	4	4		1	5	9	0	3	0.069
				summorosus		13		2	15	15	0	9	1.158
				Tripteroides dyari (?)		1			1	1	0	1	0.154
Total					5	20		3	23	28			

70697——6

The wide abaca plantations between Casiguran and Gubat, where several villages are located (Bentuco, Bulacao, Naagtan, Casay, Escuela, etc.) is a good example of a section in the Province of Sorsogon, with relatively low daytime mosquito density in houses (not treated with insecticide). Many houses in these villages were altogether negative for mosquitoes. Initial catching in Barrio Casay brought only 2 anophelines and 3 culicines (no *fatigans*). Subsequently, a more methodical search undertaken by two of the most skillful and experienced technicians of the Institute of Malariology, Mr. Jose Regalado and Mr. Romeo Ugalde, gave the following:

At Barrio Bulacao and Barrio Naagtan, August 2, 3, and 4, 1956: 70 houses were inspected, of which 38 were negative and 32, positive for mosquitoes. The catches from Barrio Bulacao were:

Species	♂♂	♀♀	Total
Culex fatigans	9	54	63
fuscocephalus	0	1	1
incognitus	0	1	1
summorosus	0	4	4
Anopheles barbirostris	0	1	1
indefinitus	0	2	2
Mansonia uniformis	0	1	1
Total	9	64	75

From Barrio Naagtan :

Species	♂♂	♀♀	Total
Culex fatigans	4	5	9
gelidus	1	1	2
incognitus	0	1	1
summorosus	0	3	3
Aedes meronephada	0	1	1
poicilius	0	1	1
Anopheles limosus	0	4	4
Total	5	16	21

August 7 and 8, 1956: Barrio Bentuco, Barrio Bulacao, and Barrio Casay. 68 houses inspected; 48 negative, 20 positive for mosquitoes.

From Barrio Bentuco:

Species	♂♂	♀♀	Total
Culex fatigans	5	10	15
incognitus	0	1	1
summorosus	0	1	1

Species	♂♂	♀♀	Total
Aedes meronephada	0	4	4
poicilius	0	2	2
Anopheles barbirostris	0	1	1
Armigeres obturbans	0	1	1
Total	5	20	25

From Barrio Bulacao:

Species	♂♂	♀♀	Total
Culex fatigans	0	2	2

From Barrio Casay:

Species	♂♂	♀♀	Total
Culex fatigans	1	6	7
incognitus	0	2	2
summorosus	0	1	1
Aedes albopictus	0	1	1
Armigeres obturbans	0	1	1
Anopheles pseudobarbirostris	0	1	1
Total	1	12	13

August 9, 1956: Barrio Bentuco and Barrio Naagtan; 78 houses inspected, 72 negative for mosquitoes. Catches from 6 houses were:

Species	♂♂	♀♀	Total
Aedes albopictus	0	1	1
meronephada	0	3	3
Anopheles vagus limosus	0	1	1
Culex fatigans	0	1	1
fuscocephalus	0	1	1
incognitus	0	5	5
summorosus	0	4	4
Total	0	16	16

In these villages, as well as in other villages surrounded by wide abaca plantations, more mosquitoes, specially *Aedes*, were found resting on abaca stalks than in houses during the day. The men assigned to collect blood smears from the inhabitants of these villages at night (8:00 p. m. to 12:00 midnight), were seriously annoyed by vicious biting *Aedes* (mostly *albopictus* and *meronephada*), *Armigeres obturbans* and *Mansonia uniformis* in the late afternoon and early evening hours while they were waiting outdoors for the right time to start their work.

Preliminary catching of mosquitoes in houses (of abaca plantations and elsewhere) in the evening (6:00 to 9:00 p. m.), and early in the morning (4:00 to 6:00 a. m.) indicated that *Aedes pampangensis* and *Aedes poicilius* aside from certain other culicines, enter houses to feed from about 8:00 or 9:00 p. m., and leave the premises before 6:00 a. m. Very few *poicilius* and hardly any *pampangensis* ever remain indoors during the day.

In contrast, in other parts of the province, the density of mosquitoes, specially *fatigans*, in houses during the day was often much higher. Moreover, a larger concentration of houses and inhabitants seemed to be accompanied by a corresponding greater predominance of *fatigans*.

Barrio Putiao of Pilar Municipality is a good example of a prosperous, growing community where, unfortunately, *fatigans* is very common. In addition to abaca plantations in this area, bananas also abound. Daytime catching in different houses of this barrio by Messrs. Jose Regalado and Romeo Ugalde showed high average catches of *fatigans* per house, and relatively few negative dwellings. (See Table 5)

TABLE 5.—*Barrio Putiao, Pilar, Sorsogon Province.*

Date 1956	Houses Inspected			Species caught	Number caught		
	Total	Positive	Negative		♂♂	♀♀	Total
July 26	10	6	4	*C. fatigans*	59	139	198
July 27	12	10	2	do	54	234	288
				C. fuscocephalus		2	2
July 31	15	14	1	*C. fatigans*	117	324	441
				A. vague limosus		2	2
August 13	9	6	3	*C. fatigans*	58	381	439
August 14	8	6	2	do	58	462	520
Auguts 15	15	13	2	do	120	609	729
August 16	15	15		do	145	495	640
Total	84	70	14	(*for fatigans only*)	611	2,644	3,255

Date 1956	♀♀ Condition of abdomen			Catches per house (Both sexes)		
	Blooded	Gravid	Empty	Minimum	Maximum	Average
July 26	66	45	28	18	48	19.80
July 27	22	46	166	13	49	24.00
			2	1	1	0.17
July 31	183	93	48	9	85	28.67
			2	1	1	0.17
August 13	220	119	42	31	185	48.78
August 14	254	134	74	35	136	65.00
August 15	318	223	68	54	175	48.60
August 16	159	161	175	10	122	42.67
Total	1,224	821	599	9	183	38.75

THE MOSQUITO VECTORS OF FILARIASIS IN SORSOGON PROVINCE

Judged solely from the percentages of infective mosquitoes as shown by dissections, the No. 1 transmitter of filariasis in Sorsogon would seem to be *Aedes poicilius*. But when considered from the standpoint of total adult mosquito population, and close association with man, *Culex fatigans* would appear to be responsible for more transmissions than *poicilius*. This is not easy to prove one way or another. *Fatigans* seems to be much fewer in communities surrounded by abaca plantation than elsewhere, and it is where abaca is plentiful that a larger number of *poicilius* would naturally be expected. Yet the total daytime house catches even in such communities show the predominance of *fatigans*. This is not surprising, though. *Fatigans* is decidedly house-frequenting and house-resting day and night, whereas *poicilius* enters houses to obtain blood meal late in the evening and leaves the premises very early in the morning. Hence, catches of *poicilius* in houses during the day do not at all represent the number of this mosquito that gets into houses during the night.

TABLE 6.—*Number of microfilaria larvæ found in mosquitoes.*

Number of microworms	*Aedes albopictus*	*Aedes poicilius*	*Aedes meronephada*	*Armigeres obturbans*	*Culex fatigans*	*Culex fuscocephalus*	*Culex incognitus*	*Culex summorosus*	*Mansonia uniformis*
1		3		1	57	3		1	
2		1			67	1	1	3	
3		1			38			1	
4		1		1	27				
5		2			17				
6					12				
7			1		6				1
8					5				
9					3				
10					1				
11					1				
12					4				
13					1				
14					3				
15	1				2			1	1
16					1				
17					2				
20								1	
21					2				
22									1
23					1				1
46					1				
Total	1	8	1	2	251	4	1	7	4
Total worms	15	22	7	5	994	5	2	45	67
Average worms	15	2.75	7	2.50	3.96	1.25	2	6.43	16.75

Catching mosquitoes at night in houses will be intensified by means of window-traps and light-traps. For comparison of catches, light-traps will likewise be tried outdoors.

Three thousand fifteen (3,015) mosquitoes representing 30 species were dissected during the filariasis survey. Positives were found in 7 species, but the infective third-stage microfilaria larvæ were present in only three species: *Aedes poicilius, Culez fatigans,* and *Culex summorosus.* Subsequently dissections after the survey showed positives (in non-infective stages) in two other species: *Aedes meronephada* and *Culex incognitus.*

Seven species were represented in 1,148 dissections made by Cabrera and Tubangui:[6] *Aedes albopictus, Aedes lineatopennis, Aedes poicilius, Armigeres obturbans, Culex fatigans, Culex summorosus,* and *Mansonia uniformis.* They found infections in three species, of which only *poicilius* had the infective worms. They obtained higher infection rates in *poicilius* and *fatigans* (35 and 14 per cent respectively), but much lower in *uniformis* (3.6 per cent). For the same species, the Institute of Malariology found infection rates of 12.12, 9.53, and 31.51 per cent respectively.

The number of microfilaria larvæ found in individual mosquitoes varied from 1 to 46, both these extremes having been registered for *fatigans.* The number of positives in other species was not sufficient to give statistically useful averages, but as they stand at this writing the highest average is in *Mansonia uniformis* (16.75 worms). The average for *fatigans,* based on 251 positives, is 3.96.

The possibility that the microfilaria worms undergo further development while in the laboratory at Tala, cannot be entirely ruled out specially in those which could not be dissected immediately. However, the majority of those found with the infective third stage microfilaria worms were dissected within 72 hours after capture; some within 48 hours; 1 within 24 hours. (See Table 7)

[6] Cabrera, B. D., and M. Tubangui. Studies on filariasis in the Philippines, III. *Aedes* (*Finlaya*) *poicilius* Theo., the mosquito intermediate host of *Wuchereria bancrofti* in the Bicol Region. Acta Medica Philippina. 7 (1951) 221–229.

TABLE 7.—*Mosquitoes with infective microfilariæ.*

Place Sorsogon Province	Date caught (1956)	Caught indoors of: DDT-treated houses	Caught indoors of: Untreated houses	Species	Date dissected at Tala (1956)	Days between capture and dissection	Number of infective worms
Barrio San Jose, Pilar	May 7	Yes		*Culex fatigans*	May 8	1	1
Do	do 15	do		do	do 18	3	2
Do	do 15	do		*Aedes poicilius*	do 18	3	2
Barrio Putiao, Pilar	do 22	do		*Culex fatigans*	do 24	2	3
Do	do 22	do		do	do 25	3	2
Santa Magdalena	do 22	do		do	do 24	2	2
Do	do	do		do	do 25	3	2
Do	do	do		do	do 25	3	1
Barrio Putiao, Pilar	June 5	do		do	June 8	3	2
Do	do	do		do	do 8	3	2
Do	do	do		do	do 8	3	1
Do	do	do		do	do 8	3	2
Do	do	do		do	do 8	3	1
Do	do	do		do	do 8	3	1
Do	do	do		do	do 8	3	1
Do	do	do		do	do 8	3	1
Do	June 6	do		do	do 8	2	1
Do	do	do		do	June 9	3	1
Do	do	do		do	do 9	3	1
Do	do	do		do	do 9	3	1
Do	do	do		do	do 9	3	1
Do	do	do		do	do 9	3	2
Barrio Puting Sapa, Juban	June 18		Yes	*Aedes poicilius*	do 22	4	1
Barrio San Ignacio, Gubat	July 5		do	do	Jul. 10	5	1
Barrio San Jose, Bulusan	do 11		do	*Culex fatigans*	do 17	6	1
Barrio Putiao, Pilar	do 24	Yes		do	do 28	4	1
Barrio Patag, Irosin	do 30	do		do	Aug. 4	5	1
Barrio Bulacao, Gubat	Aug. 2		Yes	do	do 8	6	1
Do	do 2		do	do	do 8	6	1
Do	do 2		do	do	do 8	6	1
Do	do 7		do	do	do 10	3	2
Barrio Batang, Irosin	do 9	Yes		do	do 15	6	1
Barrio San Pedro, Irosin	do 9	do		do	do 15	6	1
Barrio Putiao, Pilar	do 14	do		do	do 18	4	1
Do	do 15	do		do	do 18	3	1
Barrio Buenavista, Irosin	do 21	do		do	do 26	5	1
Barrio Putiao, Pilar	Sept. 11	do		do	Sept. 14	3	6
Do	Oct. 15	do		do	Oct. 19	4	3
Do	do 25	do		do	do 29	4	2
Barrio Cotmon, Camalig (Albay)	May 10		Yes	do	May 14	4	1
Do	do 18		Yes	do	do 21	3	2
Barrio San Jose, Pilar	do 21	Trap	catches	*Culex summorosus*	do 23	2	3
Do	do 21	do	do	do	do 23	2	1

So that this matter can be further ascertained, dissections of mosquitoes right in the field will be undertaken as soon as practicable.

Marked anthropophily seems indicated by the high infection rates in *Culex fuscocephalus* and *Mansonia uniformis* (31.59 and 31.51 per cent respectively), and though none had the infective stage of the worm, the need to investigate this problem further is very obvious. *Fuscocephalus* and *uniformis* are frequently caught in DDT-treated houses in other parts of the Philippines outside Sorsogon Province (as in Cervantes, Ilocos Sur; Aurora, Eastern Zamboanga, etc.). Whether they have now developed resistance to DDT residual spray after three yearly nationwide spraying of houses could not at that time be ascertained, but in Malaya, *uniformis* is said to be susceptible to DDT and BHC (Wharton, 1951.). This impression seems to be reversed, however, by subsequent findings. Doctor Reid in a personal communication, dated May 18, 1956, says: "..... You will see in ..... (our) ..... report that heavy doses of dieldrin seem to be the only hope in trying to attack *Mansonia* with residual insecticides."

Judging from house catches in Sorsogon Province thus far, *fatigans* seems to be the only daytime house-resting species of those found with microfilaria infections. This is specially true in areas treated with DDT. (For example: compare the catches from sprayed houses in Barrio Putiao, Santa Magdalena and Bacon with the catches from unsprayed houses of Juban and its barrios. Refer to Tables 4 and 5).

Because so few of other species, besides *fatigans,* were caught in DDT-treated houses, it was not possible to form any definite idea as to how such other species behave in relation to residual DDT. However, as two microfilaria-positive *poicilius* (one with infective worms) were caught in DDT-treated houses of Putiao and San Jose, Pilar, it would seem possible and probable that no contact or nonfatal contact with DDT could have happened with species that leave the premises soon after feeding at night. This remains to be investigated. But if such were the case, it would be necessary to spray the abaca plants (and possibly other vegetation), immediately surrounding houses. For such plants appear to be more preferred to houses as daytime refuge of mosquitoes, specially *Aedes.*

Fatigans in sprayed areas of Sorsogon Province seems now able to survive prolonged contact with residual DDT in houses.

Apart from the many specimens of *fatigans* caught in sprayed houses, which were air-shipped alive and remained alive two or more days at Tala, preliminary longivity test showed the same relatively long survival of *fatigans* after contact with DDT. Three sets of *fatigans* from Barrio San Jose, Pilar, Sorsogon Province, were tested. The first set was composed of 30 fully blooded specimens. They were caught from sprayed walls while resting on spots with very clear traces of DDT. At that time this house had already received three yearly spraying with DDT, the third spraying being on February 1, 1956. The mosquitoes were caught between 10:00 and 11:00 a. m. on May, 1956. They were, thereby, presumed to have been in contact with residual DDT for at least 4 hours, very probably more. They were caught with test tubes and kept there, 3 to a tube, separated from each other by cotton plugs. The mosquitoes were brought to the headquarters of the Malaria Unit at Legaspi, Albay Province. They were placed in a cool, dark corner of the laboratory and examined at intervals as follows:

At 11:00 a.m. on May 20, 1956, 5 or 16.67 per cent were dead; 7:00 a.m. on May 21, 1956, 16 or 33.33 per cent were dead; those still alive had completely digested their blood meals; 2:00 p.m. May 21, 1956, 9 still alive; 3:25 p.m. of the same day–1 or 3.33 per cent died. But at 7:00 a.m. on May 22, 1956, all were dead, indicating that 26.67 per cent of the original 30 *fatigans* were able to live 68 hours after capture in test tubes without water or food.

The second batch was composed of only 6 fully blooded *fatigans*, which were caught at the same time in the same house while they were resting on unsprayed, hanging clothes.

At 11:00 a.m. the next day (May 20, 1956) 2 or 33.33 per cent were dead; 7:00 a.m. on May 21, 1 or 16.67 per cent was dead; the remaining 3 had completely digested their blood meals; 6:30 p.m. on May 22, all were dead—indicating that 50 per cent were able to live for 79½ hours in test tubes without water or food.

The third set was composed of 27 fully blooded specimens. They were caught on the same date in the same Barrio, but in a different house, at about 11:30 a. m. This particular house, however, received only the first two yearly DDT–treatments; the owner refused spraying in 1956.

At 11:30 a.m. the following day (May 20), 2 or 7.41 per cent were dead; 7:00 a.m. May 21, 10 or 37.03 per cent were dead; 1:40 p.m., May 21, 1 or 3.70 per cent was dead; 2:00 p.m., May 21, 14 were

still alive, but their blood meals completely digested; 3:25 p.m., May 21, 1 was dead; 6:45 p.m., May 22, 4 were dead; 11:30 a.m., May 23, all were dead; that is, one-third (33.33 per cent) of the batch was able to survive for about 96 hours in test tubes without water or food.

About *C. fatigans* in relation to DDT residual spray in other countries, Wharton (1951) says: "..... A large proportion (of *C. fatigans*) rests indoors by day, but when DDT is applied a marked residual irritant, but not lethal, effect is observed, driving them out from their normal resting places. Resistance of *C. fatigans* to DDT deposits has been noted in the past by Ribbands (1947) and Giglioli (1948). Giglioli found a great reduction in the average *C. fatigans* population of bedrooms following residual DDT treatment but breeding continued in pit latrines nearby. Brown and Williams (1949) after a 21 months DDT spray program on the island of St. Croix concluded that the use of DDT as a residual spray could not be considered as an effective measure for the eradication of *C. fatigans* but it reduced the numbers caught in houses by 50 per cent. The present investigation supports these findings and would suggest that the use of DDT as a residual spray will not reduce the overall population of *C. fatigans,* provided suitable out of door resting places are available, but that it will reduce the biting rate of mosquitoes entering a treated room. BHC treatment on the other hand should reduce both the overall population and the biting rate.

DDT was relatively non-lethal to *C. fatigans,* but had a marked irritant effect driving them (away), and the biting rate was reduced to 45 per cent. BHC killed all *C. fatigans* which entered for 2 weeks but most of its toxic effects were lost by the eight week; the biting rate was reduced to 27 per cent for weeks 1 to 8.

In the personal communication cited above, Doctor Reid continues:

. . . . (It) seems that one can't control *C. fatigans* effectively with insecticides; certainly not applied as residuals against the adults. . . . Malathion is said to give quite good results as a larvicide against *fatigans.* DDT is useless, and though BHC and dieldrin are effective, *fatigans* larvæ quickly develop resistance to them.

Everything considered, therefore, the insecticide control of *fatigans* and other mosquitoes responsible for the transmission of filariasis in Sorsogon and other parts of the Philippines, should be given the most careful study. Wrong choice of insecticide, and incorrect application will mean useless expenses and efforts, and the penalty of subsequently dealing with insecticide-resistant mosquitoes.

THE HUMAN FACTOR

Blood smears of twelve-thousand six hundred ten (12,610; see Table 3) inhabitants of the municipalities of Barcelona (610), Bulusan (1,609), Casiguran (898), Gubat (2,303), Irosin (2,637), Juban (2,191), Prieto Diaz (1952), Sta. Magdalena (410), and Barrio Putiao of Pilar (148) were examined. Their ages varied from a little over one year to a man and a woman each of whom claimed to be 108 years old. (The man lives in Barrio Paco, Gubat, and the woman in Sitio Purog, Bulusan.) Blood smears were taken strictly at night, from about 7:30 p. m. to 12:00 midnight. The positives constituted over 10 per cent for mixed ages and sexes. These are distributed in all age-group as shown in Table 8 the youngest positives being four boys and four girls of 3 years old; the oldest, that 108-year-old man. Fifteen (15) microfilaria larvæ were found in the thick blood smear of this old man.

The distribution of positives by age-group and by sexes is about the same as that shown by Rozeboom and Cabrera (*loc. cit.* Table 4), except in the 56 to 80-year-old group, in which the much greater number examined by the Institute of Malariology showed much lower per cent of infection. Of this group, Rozeboom and Cabrera examined only 20 smears with 8 or 40.00 per cent positives.

TABLE 8a.—*Summary of blood examination by age-groups.*

Age-group (Years)	Male			Female			Both Sexes		
	Number	Positive	Per cent	Number	Positive	Per cent	Number	Positive	Per cent
1–5	539	7	1.30	409	6	1.47	948	13	1.37
6–10	1277	45	3.52	1040	49	4.71	2317	94	4.06
11–15	1574	96	6.10	1084	47	4.34	2658	143	5.38
16–20	990	99	10.00	480	43	8.96	1470	142	9.66
21–25	624	97	15.54	326	42	12.88	950	139	14.63
26–30	456	87	19.08	294	29	9.86	750	116	15.47
31–35	388	85	21.91	241	24	9.96	629	109	17.33
36–40	387	92	23.77	272	25	9.19	659	117	17.75
41–45	356	89	25.00	247	34	13.77	603	123	20.40
46–50	309	76	24.60	206	26	12.62	515	102	19.81
51–55	170	45	26.47	122	13	10.66	292	58	19.86
56–60	216	46	21.30	124	14	11.29	340	60	17.65
61–65	99	30	30.30	45	8	17.78	144	38	26.39
66–70	80	14	17.50	45	8	17.78	125	22	17.60
71–75	27	6	22.22	14	1	7.14	41	7	17.07
76–80	26	10	38.46	11	2	18.18	37	12	32.43
81–85	6	1	16.66	1	0	0	7	1	12.50
86–90	3	0	0	1			4	0	0
91–95	2	0	0				2	0	0
96–100									
101–105									
106–110	1	1	100.00	1	0	0	2	1	50.00
Total	7530	926	12.30	4963	371	7.48	12,493	1297	10.38

TABLE 8b.—*Summary of blood examinations by age groups, by sexes, and by localities*—Continued.

Localities		1 to 5 years		6 to 10 years		11 to 15 years		16 to 20 years		21 to 25 years		26 to 30 years		31 to 35 years	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
BULUSAN															
Poblacion	*M	10	0	58	1	123	7	70	5	45	5	19	3	17	2
	F	17	0	40	1	56	4	14	2	6	0	7	0	1	0
Buhang (San Vicente)	M	2	0	28	0	20	0	6	0	4	0	3	0	5	0
	F	1	0	22	0	20	1	2	0	1	0	1	0	4	0
Dancalan	M	2	0	10	2	17	4	8	0	5	2	3	1	4	0
	F	1	0	13	1	15	0	3	1	7	1	4	1	2	0
Purog	M	10	0	11	0	6	1	6	0	6	1	5	3	1	0
	F	4	0	10	1	6	0	8	1	6	2	4	1	2	1
Sta. Barbara	M	10	1	7	1	13	3	6	1	4	2	3	1	1	0
	F	2	0	9	0	3	0	3	0	7	1	2	0		
San Francisco	M	4	0	5	0	14	1	4	1	6	2	2	1	3	0
	F	2	0	21	1	15	0	7	2	1	0			2	0
San Isidro	M	8	0	25	1	35	3	14	5	10	5	2	1	2	0
	F	2	0	23	2	18	2	4	0	4	2			5	0
San Jose	M	4	0	8	1	14	4	4	2	8	3	1	1	3	3
	F	7	1	5	3	7	1	3	0	1	0				
San Rafael	M	6	0	8	0	13	2	5	0	3	0	1	1	2	1
	F	6	0	21	3	5	1	3	0	4	1	2	0	1	0
San Roque	M	1	0	23	0	15	0	4	0	6	0	5	1	3	1
	F	1	0	13	1	5	0								
Total	M	57	1	188	6	270	25	127	14	97	20	44	13	41	7
	F	43	1	177	13	150	9	47	6	37	7	20	2	17	1
Total: Both sexes		100	2	360	19	420	34	174	20	134	27	64	15	58	8

* M, Male; F, Female.

Localities		36 to 40 years		41 to 45 years		46 to 50 years		51 to 80 years		Total		Both sexes	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
BULUSAN													
Poblacion	M	22	2	14	3	16	2	26	7	420	37	594	46
	F	4	0	4	0	8	0	17	2	174	9		
Buhang (San Vicente)	M	1	0	7	1	7	1	11	2	94	4	150	5
	F			3	0			2		56	1		
Dancalan	M	4	1	4	2	2	0	15	4	74	16	132	23
	F	3	0	1	0	1	0	8	3	58	7		
Purog	M	2	0	2	1	2	0	6	1	57	7	103	13
	F	3	0	1	0	1	0	1	0	46	6		
Sta. Barbara	M	1	0	4	2	2	2	2	1	53	14	85	17
	F	3	1			1	0	2	1	32	3		
San Francisco	M	2	0	4	1	1	0	2	1	47	7	104	10
	F	3	0			3	0	3	0	57	3		
San Isidro	M	1	1	1	0	6	2	1	1	105	19	175	30
	F	2	1	8	4	2	0	2	0	70	11		
San Jose	M	1	1	3	0			1	1	47	16	73	22
	F			1	0	2	1			26	6		
San Rafael	M	2	1	1	1	1	1	8	2	50	9	102	17
	F	5	1	1	1	3	1	1	0	52	8		
San Roque	M	3	0	2	0			6	1	68	3	91	4
	F	1	0	3	0					23	1		
Total	M	39	6	42	11	37	8	78	21	1,015	132	1,609	187
	F	24	3	22	5	21	2	36	6	594	55		
Total: Both sexes		63	9	64	16	58	10	114	27	1,609	187		

TABLE 8b.—*Summary of blood examinations by age groups, by sexes, and by localities*—Continued.

Localities		1 to 5 years		6 to 10 years		11 to 15 years		16 to 20 years		21 to 25 years		26 to 30 years		31 to 35 years	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
CASIGURAN															
Banawang	M	4	0	5	2	2	0	4	1	4	2	2	0	5	3
	F	1	0	3	0	2	0	5	0	2	2	1	0		
Boton and Cagdagat	M	8	0	21	0	26	0	13	1	8	4	6	0	2	0
	F	7	0	28	1	7	0	3	0	3	0	6	0	2	0
Casay	M	4	0	11	0	2	0	5	0	4	0	3	0	3	3
	F	4	1	6	2	5	0	4	2	2	0	5	0	3	1
Escuala	M			3	0	4	0	3	0	4	1	1	0	4	1
	F			3	0	3	0	3	0	2	0	2	0	2	0
Inlagadian	M	1	0	4	0	9	2	4	1	2	0	4	1	2	0
	F	4	1	9	0	4	1	4	1	2	0	2	0	1	0
Mabini	M	3	1	8	1	4	1	6	0	3	0	2	0	4	0
	F	6	0	11	0	2	0	1	0			2	0	2	0
Rizal	M	3	0	10	0	11	0	6	0	3	0	2	0	5	1
	F			2	0	2	0	2	0	2	0	4	0	1	0
San Juan	M	10	0	9	1	16	2	8	0	3	0	4	1	7	1
	F	6	0	13	2	6	0	9	1	4	1	5	0		
Trece Martires	M	10	0	14	0	21	0	15	0	3	1			8	0
	F	11	0	21	0	19	0	6	0	4	0	6	0	6	0
Total	M	43	1	85	4	95	5	64	3	34	8	24	2	40	9
	F	39	2	96	5	50	1	37	4	21	3	33	0	17	1
Total: Both sexes		82	3	181	9	145	6	101	7	55	11	57	2	57	10

Localities		36 to 40 years		41 to 45 years		46 to 50 years		51 years and over		Total		Both sexes	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
CASIGURAN													
Banawang	M	3	0	4	2	2	1	1	0	36	11	52	14
	F					2	1			16	3		
Boton and Cagdagat	M	4	1	3	0	7	1	12	2	110	9	183	12
	F	3	0	4	1	4	1	6	0	73	3		
Casay	M	2	0	5	1	1	0			40	4	74	10
	F	1	0	1	0	1	0	2	0	34	6		
Escualla	M	1	0	1	0	4	1	6	2	31	5	53	9
	F					5	3	2	1	22	4		
Inlagadian	M	5	2	1	0	5	3	4	2	41	11	76	17
	F	1	0	3	1	3	1	2	1	35	6		
Mabini	M	6	4	2	0	4	1	6	3	48	11	76	12
	F	1	0					3	1	28	1		
Rizal	M	4	0			3	1	5	1	52	3	73	3
	F			1	0	1	0	6	0	21	0		
San Juan	M	3	1	5	2	1	1	7	0	73	9	127	14
	F	4	0	4	1	2	0	1	0	54	5		
Trece Martires	M	3	0	6	1	5	1	8	1	93	4	184	5
	F	3	0	4	1	3	0	8	0	91	1		
Total	M	31	8	27	6	32	10	49	11	524	67		
	F	13	0	17	4	21	6	30	3	374	29	898	96
Total: Both sexes		44	8	44	10	53	16	79	14	898	96		

TABLE 8b.—*Summary of blood examinations by age groups, by sexes, and by localities*—Continued.

Localities		1 to 5 years		6 to 10 years		11 to 15 years		16 to 20 years		21 to 25 years		26 to 30 years		31 to 35 years	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
GUBAT															
Mixed places	M					17	1	17	0	5	1	3	0	5	2
	F					2	0			2	1	2	0		
Ariman	M	6	0	17	0	8	0	5	0	2	0	1	0	3	0
	F	5	0	4	0	9	0	2	0	2	0	5	0	7	0
Bagacay	M	5	0	23	0	48	1	17	1	8	0	9	1	5	2
	F	2	0	33	0	21	1	10	1	2	0	1	0		
Benguet	M	4	0	4	1	7	1	4	0	1	0	1	0	2	1
	F	5	0	3	0	2	1	3	0			1	0	2	0
Bentuco	M	1	0	4	0	10	2	7	0	5	3	12	2	4	0
	F			3	0	5	1			1	1	4	1	1	0
Bereran	M	2	0	6	0	6	0	3	0	4	0	1	0	3	0
	F	2	0	1	0	7	0	5	0	5	1	2	0	1	0
Buenavista	M	4	0	13	0	5	2	7	2			1	0	2	1
	F	4	0	10	0	15	0					1	1	2	0
Bulacao	M			2	0	3	0			1	0			2	0
	F			3	0	7	0	3	0					2	0
Carriedo	M	2	0	5	0	10	0	2	0	1	0	4	0	2	0
	F			6	0	10	0	1	0	1	0	1	0		
Cogon	M	4	0	8	0	8	0	5	0					1	0
	F	1	0	2	0	5	0	2	0			1	0	1	0
Malinao	M	1	0	16	2	17	3	7	0	12	2	5	1	1	0
	F	1	0	11	1	23	1	3	0	2	0	3	1	1	0

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TABLE 8b.—*Summary of blood examinations by age groups, by sexes, and by localities*—Continued.

Localities		36 to 40 years		41 to 45 years		46 to 50 years		51 to 108 years		Total		Both sexes	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
GUBAT													
Mixed places	M	3	2	3	2	1	0	2	1	56	9	62	10
	F									6	1		
Ariman	M	2	0	1	1	3	0	2	0	50	1	86	1
	F	1	0			1	0			36	0		
Bagacay	M	3	0	3	0	3	2	4	0	128	7	206	10
	F	2	0	2	1	2	0	3	0	78	3		
Benguet	M	2	0	2	0	1	1	3	0	31	4	48	5
	F					1	0			17	1		
Bentuco	M	5	1	6	4	1	1	8	0	63	13	81	16
	F	1	0	2	0			1	0	18	3		
Bereran	M	4	0	3	1			2	1	34	2	64	5
	F	1	0	2	1	2	1	2	0	30	3		
Buenavista	M	6	0	6	0	2	0	1	0	47	5	80	6
	F			1	0					33	1		
Bulacao	M	2	0			2	0			12	0	31	1
	F	1	0	1	1	1	0	1	0	19	1		
Carriedo	M	2	0	2	0	4	0	8	0	42	0	70	2
	F	1	0	1	0	4	0	3	2	28	2		
Cogon	M	3	0	2	0			4	0	35	0	52	0
	F	3	0			1	0	1	0	17	0		
Malinao	M	3	2	5	0	2	0	1	0	69	10	120	13
	F	1	0	2	0	4	0			51	3		

Naagtan	M	1	1	4	0	1	0	8	1	62	8	92	10
	F	2	0			1	1	3	0	30	2		
Paco	M	6	4	2	0	4	3	8	4	81	21	162	32
	F	2	1	5	1	3	0	6	1	81	11		
Payawin	M	1	0	2	1	4	1	3	1	39	10	62	15
	F	3	2	4	0			2	1	23	5		
Rizal	M	3	0	3	0	4	2	14	2	80	6	158	11
	F	3	1	3	1	5	0	10	2	78	5		
San Ignacio	M	3	0	6	1	2	0	3	1	75	4	142	5
	F	4	0	5	0	3	0	5	0	67	1		
Sangat	M	1	0	2	1	2	1	2	1	77	12	108	14
	F			1	1	1	0	3	0	31	2		
Santa Ana	M	4	2	8	6	2	1	6	3	64	20	85	24
	F	1	1	3	1					21	4		
Tabe	M	8	1	9	3	3	1	5	2	124	12	236	21
	F	5	2	2	0	8	1	4	0	112	9		
Tagaytay	M	1	1			3	1	2	0	49	6	88	9
	F	3	1	2	0	2	0			39	3		
Teres	M	3	0	6	0	1	0	4	1	43	3	72	7
	F	4	1	1	0	1	0	6	2	29	4		
Tugawi	M	2	0			2	2	5	2	34	8	63	17
	F	2	1	3	3	3	1	2	0	29	9		
Union	M			3	1	5	3	6	1	42	10	67	10
	F	1	0	3	0			3	0	25	0		
Villareal	M			1	1	1	0	5	2	24	5	51	10
	F			1	0	4	2			27	5		
Total	M	67	14	79	22	53	19	106	28	1,361	176	2,265	254
	F	41	10	44	10	47	6	55	8	904	78		
Total: Both sexes		108	24	123	32	100	25	161	31	2,265	254		

TABLE 8b.—*Summary of blood examinations by age groups, by sexes, and by localities*—Continued.

Localities		1 to 5 years		6 to 10 years		11 to 15 years		16 to 20 years		21 to 25 years		26 to 30 years		31 to 35 years	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
IROSIN															
Poblacion	M	38	0	94	0	126	5	76	3	35	2	39	4	26	5
	F	21	0	53	0	69	1	39	2	20	0	16	0	18	1
Batang	M	7	0	5	0	8	0	6	2			5	0	4	0
	F	2	0	5	0	4	0	2	0	2	0	1	0	2	0
Bolos	M	3	1	4	0	3	1	2	1	1	0	2	1	3	1
	F	1	0	4	0			1	0			2	0	1	1
Buenavista	M	2	0	5	0	5	0	7	0	1	0	1	0	8	1
	F	1	0	4	0	2	0	1	0			3	0	1	1
Carriedo	M	8	0	14	0	11	0	1	1	1	0	3	0	3	0
Cavite	F	3	0	8	0	15	1	5	0	2	0	2	0	1	0
Cassini	M	12	0	13	0	4	0	9	0	4	0	3	1	3	1
	F	5	0	10	1	5	0	2	0	2	0	3	0	2	0
Cogon	M	6	0	13	0	12	2	2	0	4	1			3	0
	F	3	0	8	1	4	0	2	0	4	2	5	0	1	1
Gabao	M	10	0	44	2	38	1	34	2	26	4	18	2	13	3
	F	4	0	35	1	31	2	6	0	10	0	6	0	5	1
Gulang-Gulang and Magon	M	2	0	6	1	5	0	15	1	10	3	6	1	4	0
	F	1	0	1	0	2	0	2	1	3	0			3	1

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TABLE 8b.—*Summary of blood examinations by age groups, by sexes, and by localities*—Continued.

Localities		36 to 40 years		41 to 45 years		46 to 50 years		51 years and over		Total		Both sexes	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
IROSIN													
Poblacion	M	9	0	19	3	20	4	43	5	525	31	836	40
	F	22	0	11	1	11	1	31	3	311	9		
Batang	M	4	1	3	0	7	0	5	1	54	4	78	4
	F	1	0	1	0	3	0	1	0	24	0		
Balos	M	2	1	1	1			3	1	24	8	37	9
	F			3	0	1	0			13	1		
Buenavista	M	3	2	4	0	3	0	2	0	41	3	60	4
	F	5	0			2	0			19	1		
Carriedo	M	3	2	3	0			4	1	51	4	100	5
Cavite	F	1	0	5	0	2	0	5	0	49	1		
Cassini	M	2	0	2	0	1	0	3	1	56	3	19	4
	F	2	0			2	0	2	0	35	1		
Cogon	M	3	0			2	0	6	1	51	4	88	9
	F			3	0	5	1	2	0	37	5		
Gabao	M	16	4	5	1	8	3	6	2	218	24	332	28
	F	5	0	3	0	4	0	5	0	114	4		
Galang-Galang and Magon	M	8	2	5	2	3	1	7	2	71	13	92	15
	F	3	0	4	0	1	0	1	0	21	2		

Lamboon	M	3	0	5	0		1	0	1	0	47	1	85	4		
	F	1	0	1	0		1	0	2	0	38	3				
Macawayan	M	6	0	4	0		4	1	5	0	99	5	185	7		
	F	5	0	5	0		2	0	6	0	86	2				
Mapaso and Patag	M	9	2	7	3		7	3	6	3	167	26	299	42		
	F	8	3	6	2		3	0	2	1	132	16				
Salvacion	M	5	4	6	2		1	0	4	2	54	12	89	16		
	F	2	0	1	0		1	0	1	0	35	4				
San Benon	M	1	0	2	0						15	0	29	1		
	F										14	1				
Tabon-tabon	M	2	0	3	2		2	1	2	0	25	4	48	7		
	F	1	0						1	0	23	3				
Total	M	76	18	64	12		58	13	97	19	1,498	142	2,449	196		
	F	56	3	48	5		38	2	59	4	951	53				
Total: Both sexes		132	21	112	17		96	15	156	23	2,449	195				

TABLE 8b.—*Summary of blood examinations by age groups, by sexes, and by localities*—Continued.

Localities		1 to 5 years		6 to 10 years		11 to 15 years		16 to 20 years		21 to 25 years		26 to 30 years		31 to 35 years	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
JUBAN															
Poblacion	M	5	0	15	0	14	0	25	3	15	0	8	0	3	0
	F	10	0	8	0	23	3	13	0	11	0	10	1	8	0
Binanwahan	M	1	0	5	0	9	1	10	0			2	0	4	0
	F	2	0	3	0	3	0	2	1	3	0			2	0
Capilihan	M			2	1	3	1	2	2	1	1	3	1	1	0
	F														
Cogon	M	1	1	4	1	10	1	10	1	5	0	1	1	1	0
	F			1	0	7	0	1	0	1	0	3	1		
Tughan	M	2	0	7	0	9	0	6	0	3	0	5	1	4	0
	F	1	0			2	0					1	0	3	0
Aniog	M	2	0	14	2	15	1	7	2	2	0	8	2	5	3
	F	1	0	8	1	13	2	2	0	3	2	1	0		
Puting Sapa	M	1	0	5	0	3	0	5	2	5	0	5	0	5	0
	F	2	0			1	0	1	0	1	0	1	0	1	1
Areroy	M	5	1	10	2	4	0	4	1	3	0	2	1	2	1
	F	4	0	3	1	4	0	2	0	1	0	4	0	1	1
Bacolod	M	6	0	12	1	7	1	14	5	15	2	4	0	4	1
	F	3	0	6	1	11	0	9	0	4	0	2	0		
Mapili	M	10	0	15	2	8	0	7	1	4	2	2	1	4	0
	F	10	0	9	0	8	0	7	1	6	0	4	0	2	0
Sangcayon	M	6	0	5	0	8	0	10	4	2	1	3	0	5	2
	F	3	0	4	3	8	0	2	1	4	2	4	1	2	2
Bereran	M			6	0	10	0	9	2	8	2	5	1	4	2
	F			5	0	5	0	6	1	2	0	4	0	2	0
Pulangduta	M	3	0	4	0	4	0	4	0	7	0	2	0	1	1
	F	2	0	1	0	4	0	4	0	2	0			1	0
Buraburan	M	1	0	3	0	2	0	1	0	6	1	2	0	1	1
	F	1	0			1	0	1	0	2	0	5	1	1	0

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TABLE 8b.—*Summary of blood examinations by age groups, by sexes, and by localities*—Continued.

Localities		36 to 40 years		41 to 45 years		46 to 50 years		51 to 108 years		Total		Both sexes	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
JUBAN													
Poblacion	M	7	2	9	0	5	0	17	2	123	7	243	11
	F	13	0	6	0	6	0	12	0	120	4		
Binanwahan	M	5	0	1	0	3	0	3	1	43	2	67	3
	F			3	0	4	0	2	0	24	1		
Capilihan	M	2	1	1	0	2	0	3	1	20	8	20	8
	F												
Cogon	M	5	4	1	0	1	0	8	3	47	12	66	14
	F	1	0	1	0	1	0	3	1	19	2		
Tughan	M	3	0	4	0			3	1	46	2	62	2
	F	2	0	1	0	1	0	5	0	16	0		
Aniog	M	2	1	4	1	4	1	3	1	66	14	101	20
	F	3	0	1	1	2	0	1	0	35	6		
Puting Sapa	M	1	0	2	1	2	0	3	1	37	4	48	7
	F			2	1			2	1	11	3		
Aroroy	M	6	3	2	0			5	2	43	11	70	15
	F			4	0	1	0	3	2	27	4		
Bacolod	M	5	1	1	0	4	0	12	2	84	13	132	14
	F	3	0	2	0	2	0	6	0	48	1		
Masili	M	2	1	3	1	5	1	4	0	64	9	120	11
	F	2	0	1	0	1	0	6	1	56	2		
Sangcayon	M	2	0			1	1	6	2	48	10	75	22
	F	1	0	1	1	2	1	1	1	27	12		
Bereran	M	4	3	4	1	4	1	9	3	63	15	100	17
	F	3	0	3	0	2	0	5	1	37	2		
Pulanduta	M			2	1	1	0	3	1	31	3	50	3
	F	1	0	3	0	1	0			19	0	50	3
Buraburan	M	1	0	3	2	3	1	4	1	27	5	48	9
	F	1	0			1	0	8	2	21	4		

| | | |

TABLE 8b.—*Summary of blood examinations by age groups, by sexes, and by localities*—Continued.

Localities		1 to 5 years		6 to 10 years		11 to 15 years		16 to 20 years		21 to 25 years		26 to 30 years		31 to 35 years	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
PRIETO DIAZ															
Poblacion	M	7	0	36	1	52	1	30	5	20	2	3	1	7	0
	F	9	0	37	0	45	0	28	0	14	1	10	1	11	1
Binontolan	M	6	0	12	0	4	0	7	1	2	0	2	0	1	0
	F	4	0	6	0	6	0	2	1	2	0	2	0		
Bulawan	M	6	0	18	0	16	0	3	0	1	0	2	0	1	0
	F	4	0	4	0	13	0	3	0	3	0	5	1	2	0
Cagbulalacao	M	1	0	7	1	4	1	4	1	2	1	3	2	4	2
	F	4	0	4	1	7	0	3	0	2	1	2	1	1	0
Calao	M	5	0	35	2	33	1	10	0	6	2	2	0	4	0
	F	3	0	24	0	18	0	4	0	3	0	1	0	4	0
Carayat	M	5	0	8	1	6	1	7	2	4	3	6	5	2	0
	F	1	0	4	0	6	0	6	1	3	0	1	0	2	1
Cayo	M	29	0	24	1	30	1	4	1	2	0	4	0	3	1
	F	17	0	27	3	20	0	3	0	8	2	5	0	7	1
Cogon	M	8	0	6	0	17	0	7	1	8	2	5	2	1	0
	F	5	0	6	0	11	0	4	0	4	0	2	0	3	0
Lupi	M	6	0	25	0	21	1	5	1	2	0	6	1	4	1
	F	4	0	15	0	14	0	5	0	4	0	3	0	4	1
Manlabong	M	4	0	16	1	23	2	7	0	4	1	5	1	4	0
	F	6	0	14	1	15	2	1	0			5	0		
Pigtaclaan	M	16	0	8	0	9	0	13	0	7	0	5	0	4	0
	F	11	0	18	0	7	0	8	0	4	0	3	0	1	0
Quidolog	M	9	0	30	0	19	1	11	1	4	0	9	0	1	0
	F	8	0	17	0	16	0	2	0	2	0	3	0	4	0
Visitang Daan	M	12	0	15	1	27	1	9	2	4	1	2	0	4	1
	F	4	0	9	1	15	2	2	0	4	2	4	0	2	1
Total	M	114	0	240	8	261	10	117	15	66	12	54	12	40	5
	F	80	0	185	6	193	4	71	2	53	6	46	3	41	4
Total: Both sexes		194	0	425	14	454	14	188	17	119	18	100	15	81	9

Localities		36 to 40 years		41 to 45 years		46 to 50 years		51 years and over		Total		Both sexes	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
PRIETO DIAZ													
Poblacion	M	10	1	9	2	12	1	26	5	212	19	410	24
	F	12	0	9	1	8	0	15	1	198	5		
Binontolan	M	4	1	1	1			1	1	40	4	69	7
	F	4	1	1	0	1	1	1	0	29	3		
Bulawan	M	1	0	3	1			1	0	52	1	96	2
	F	2	0	2	0	1	0	5	0	44	1		
Cagbulalacao	M	2	0	2	1			2	1	31	10	61	14
	F	3	0	3	0	1	1			30	4		
Calao	M	4	1	2	0	1	0	4	1	106	7	174	8
	F	4	0	4	0	1	0	2	1	68	1		
Carayat	M			3	1	1	0	6	1	48	14	78	17
	F	2	0	1	0			4	1	30	3		
Cayo	M	5	3	2	0	3	1	6	0	112	8	214	18
	F	4	1	4	2	1	1	6	1	102	10		
Cogon	M	2	0	2	0	2	0	3	0	61	5	104	5
	F	1	0	1	0	4	0	2	0	43	0		
Lupi	M	7	1	1	0	1	0	6	2	84	7	145	10
	F	4	0	2	0	1	1	5	1	61	3		
Manlabong	M	3	1	2	1	1	0	3	1	72	8	124	15
	F			2	0	3	1	6	3	52	7		
Pigtaclaan	M	1	0	7	0			1	0	71	0	129	0
	F	3	0					3	0	58	0		
Quidolog	M	4	0	6	1	3	2	5	0	101	5	171	6
	F	7	1	5	0	1	0	5	0	70	1		
Visitang Daan	M	5	3	1	0			4	1	83	10	136	18
	F	4	1	2	0	2	1	5	0	53	8		
Total	M	48	11	41	8	24	4	68	13	1,073	98	1,911	144
	F	50	4	36	3	24	6	59	8	838	46		
Total: Both sexes		98	15	77	11	48	10	127	21	1,911	144		

TABLE 8b.—*Summary of blood examinations by age groups, by sexes, and by localities*—Continued.

Localities		1 to 5 years		6 to 10 years		11 to 15 years		16 to 20 years		21 to 25 years		26 to 30 years		31 to 35 years	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
BARCELONA															
Bongate	M	2	0	7	2	7	0	7	0	7	0	4	0	2	1
	F	2	0	2	0	6	0	2	0	1	0	1	0	1	0
Layog	M	4	0	10	0	26	3	6	0	11	1	5	2	2	1
	F	4	0	13	1	8	0	5	0	2	0			3	
Macabarri	M	1	0	11	0	21	0	16	1	9	0	4	0	3	0
	F	2	0	11	0	6	0	4	0	4	0	2	1	2	0
Paghaluban	M	15	0	27	0	25	1	7	0	6	0	9	2	7	1
	F	15	0	28	0	23	0	6	0	8	0	8	0	5	1
Total	M	22	0	55	2	79	4	36	1	33	1	22	4	14	3
	F	23	0	54	1	43	0	17	0	15	0	11	1	11	1
Total: Both sexes		45	0	109	3	122	4	35	4	53	1	33	5	25	4
PILAR															
Putiao	M			2	0	15	0	23	0	14	1	8	0	6	2
	F			3	0	17	0	16	2	7	1	2	0	2	0
Total				5	0	32	0	39	2	21	2	10	0	8	2
MAGDALENA															
Poblacion	M					28	1	39	2	15	1	7	1	4	0
	F					23	1	12	1	10	1	2	0	3	0
Salvacion	M			1	1	14	2	18	2	15	5	10	5	7	2
	F			1	0	14	1	5	2	2	1	3	0	2	0
San Sebastian	M			4	0	17	3	7	1	8	4	6	3	3	1
	F			3	0	9	3	3	0	4	3	4	0	1	0
Total	M			5	1	59	6	64	5	38	10	23	9	14	3
	F			4	0	46	5	20	3	16	5	9	0	6	0
Total: Both sexes				9	1	105	11	84	8	54	15	32	9	20	3

Localities		36 to 40 years		41 to 45 years		46 to 50 years		51 years and over		Total		Both sexes	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
BARCELONA													
Bongate	M	8	2	3	2	2	1	5	1	54	9	75	10
	F	2	0			3	1	1	0	21	1		
Layog	M	5	0	5	2	4	2	12	2	90	13	146	14
	F	6	0	5	0	4	0	6	0	56	1		
Macabarri	M	7	1	3	2	7	1	9	2	91	7	145	10
	F	6	0	7	0	4	0	6	2	54	3		
Paghaluban	M	4	0	7	0	7	1	14	3	128	8	244	9
	F	10	0	6	0	1	0	6	0	116	1		
Total	M	24	3	18	6	20	5	40	8	363	37	610	43
	F	24	0	18	0	12	1	19	2	247	6		
Total: Both Sexes		48	3	36	6	32	6	59	10	610	43		
PILAR													
Putiao	M	5	2	5	2	4	0	9	2	91	9	148	13
	F	4	0	2	0	1	0	3	1	57	4		
Total		9	2	7	2	5	0	12	3	148	13		
MAGDALENA													
Poblacion	M	3	0	7	2	7	2	17	4	127	13	194	17
	F	2	1	1	0	6	0	8	0	67	4		
Salvacion	M	2	2	5	3	2	1	9	8	83	31	119	36
	F	1	1	1	0	2	0	5	0	36	6		
San Sebastian	M	6	0	1	0	1	1	10	5	63	18	97	26
	F	3	1			2	1	5	0	34	9		
Total	M	11	2	13	5	10	4	36	17	273	62	410	79
	F	6	3	2	0	10	1	18	0	137	17		
Total: Both sexes		17	5	15	5	20	5	54	17	410	79		

TABLE 8c.—*Infections by age groups, by sexes, and by localities.*

Localities		51 to 55 years		56 to 60 years		61 to 65 years		66 to 70 years		71 to 75 years		76 to 80 years	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
Barcelona	M	9	5	17	1	9	1	3	1	2	0		
	F	5	2	8	0	3	0	2	0	1	0		
Bulusan	M	19	4	25	7	11	3	13	2	5	2	4	3
	F	10	2	20	1	2	1	1	1	1	1	1	0
Casiguran	M	14	2	14	3	7	3	5	1	2	1	1	0
	F	11	0	12	1	1	1	4	1			2	0
Gubat	M	32	10	40	7	16	2	11	2	2	0	3	1
	F	24	4	16	2	7	1	5	1	1	0	2	0
Irosin	M	30	8	37	8	9	2	12	0	5	0	3	1
	F	16	0	17	3	9	1	10	0	3	0	2	0
Juban	M	36	8	49	11	27	11	17	3	6	1	10	5
	F	23	1	29	5	14	3	12	4	6	0	1	1
Putiao (Pilar)	M	2	0	1	0	3	2	1	0	2	0		
	F	2	1			1	0						
Prieto Diaz	M	18	4	24	4	12	2	12	3			2	0
	F	24	3	18	2	6	1	9	1	1	0	1	1
Santa Magdalena	M	10	4	9	5	5	4	6	2	3	2	3	0
	F	7	0	4	0	2	0	2	0	1	0	2	0
Total	M	170	45	216	46	99	30	80	14	27	6	26	10
	F	122	13	124	14	45	8	45	8	14	1	11	2
Total: Both sexes		292	58	340	60	144	38	125	22	41	7	37	12

Localities		81 to 85 years		86 to 90 years		91 to 95 years		105 to 110 years		Total		Both sexes	
		Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive	Number	Positive
Barcelona	M									40	8	59	10
	F									19	2		
Bulusan	M					1	0			78	21	114	27
	F							1	0	36	6		
Casiguran	M	4	1	2	0					49	11	79	14
	F									30	3		
Gubat	M			1	0			1	1	106	23	161	31
	F									55	8		
Irosin	M					1	0			97	19	156	23
	F	1	0	1	0					59	4		
Juban	M	2	0							147	39	232	53
	F									85	14		
Putiao (Pilar)	M									9	2	12	3
	F									3	1		
Prieto Diaz	M									68	13	127	21
	F									59	8		
Santa Magdalena	M									36	17	54	17
	F									18	0		
Total	M	6	1	3	0	2	0	2	1	631	153	994	199
	F	1	0	1					0	363	46		
Total: Both sexes		7	1	4	0	2	0	2	1	994	199		

TABLE 9.—*Number of microfilaria larvæ by age groups.*

[Excluding a number of positive smears.]

Number of worms	1 to 5 years			6 to 10 years			11 to 20 years			21 to 30 years			31 to 40 years			41 to 50 years		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1–5	4	4	8	17	23	40	90	38	128	57	30	87	57	25	82	51	31	82
6–10				12	7	19	36	5	41	31	14	45	29	9	38	27	10	37
11–20	1	2	3	6	7	13	27	11	38	36	13	49	23	4	27	27	9	36
21–30				3	3	6	6	7	13	14	2	16	7	6	13	20	3	23
31–40				2	1	3	6	5	11	8	2	10	9	1	10	5	2	7
41–50	1		1	2		2	6	3	9	5		5	11	1	12	10	2	12
51–60	1		1				2	3	5	7	1	8	3		3	2		2
61–70								1	1	4		4	3	1	4	4		4
71–80				1		1		3	3	1	1	2	5		5	8		8
81–90				1		1				3		3	1	1	2	1		1
91–100										2		2		1	1	1		1
101–110							1		1	1		1	1		1	2	1	3
111–120										1		1						
121–130				1		1	1		1				3		3			
131–140							1		1				1		1	2		2
141–150							2		2	2		2	1		1			
151–160										1		1	1		1	2		2
161–170							1		1				1		1			
171–180							1		1							1		1
181–200										2		2						
203																		
220													1		1			
226													1		1			
245								1	1									
255																		
257							1		1									
268													1		1			
298										1		1						
303													1		1			
345																1		1
383																1		1
397													1		1			
420										1		1						
Total	7	6	13	45	41	86	181	77	258	177	63	240	161	49	210	165	58	223

Number of worms	51 to 60 years			61 to 70 years			71 to 80 years			81 to 85 years			108		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
1–5	33	10	43	7	4	11	2	1	3						
6–10	15	4	19	11	3	14	5		5	1		1			
11–20	14	4	18	7	1	8	6		6				1		1
21–30	5	1	6	5	2	7	2		2						
31–40	6		6	2	1	3	1		1						
41–50	4	1	5	2		2	2		2						
51–60	4	1	5	1		1									
61–70				1		1	1		1						
71–80	2	1	3												
81–90	2	1	3												
91–100	1		1	1		1									
101–110	1		1	1		1		1	1						
111–120															
121–130	1		1	1		1									
131–140															
141–150				1		1		1	1						
151–160	1		1												
161–170															
171–180				1		1									
181–200															
203	1		1												
220															
226															
245															
255				1		1									
257															
268															
293															
303															
345															
383															
397															
420															
Total	90	23	113	42	13	55	16	3	19	1		1	1		1

TABLE 10.—*Age-group distribution of elephantiasis.*

	11 to 20 years			21 to 30 years			31 to 40 years		
	Blood negative	Blood positive	Total	Blood negative	Blood positive	Total	Blood negative	Blood positive	Total
Male	1	1	2	8	3	11	14	5	19
Female									
Total	1	1	2	8	3	11	14	5	19

	41 to 50 years			51 to 60 years			61 to 70 years		
	Blood negative	Blood positive	Total	Blood negative	Blood positive	Total	Blood negative	Blood positive	Total
Male	27	10	37	15	9	24	9	4	13
Female	2	1	3	2	0	2			
Total	29	11	40	17	9	26	9	4	13

	71 to 80 years			81 to 90 years			Total: Both sexes		
	Blood negative	Blood positive	Total	Blood negative	Blood positive	Total	Blood negative	Blood positive	Total
Male	1	1	2	1		1	76	33	109
Female							4	1	5
Total	1	1	2	1		1	80	34	114

The total (12,758) shown in Table 3 is less than the total (12,493) given in Table 7 simply because the original records of those taken from 3 barrios were lost in transit.

The houses in Juban and its barrios were not sprayed with any insecticide, and though the dwellings in some communities of Bulusan, Casiguran, Gubat, and Prieto Diaz were already three times treated with DDT, the villages selected for the Filariasis Survey were not sprayed. Most of those taken from Irosin, however, were from sprayed localities, while those from Santa Magdalena and its two barrios, and those from Barrio Putiao of Pilar were entirely from people living in sprayed houses.

Thick blood films were taken. These were sent to the Institute of Malariology for reading. The men used in the survey were highly experienced technicians. But the blood smears were of course neither exactly equal in sizes nor in amount of blood. The parasite counts could, therefore, be at best of very relative meaning. Nevertheless, they give a general idea of how heavily or lightly a victim was infected. Of those counted, the range and average in number of parasites, the ages and sexes of the hosts are indicated in Table 9.

High parasite-count were not confined to any particular age-group, although the highest were in age-group 21 to 30, 31 to 40, and 41 to 50. A 3-year-old boy had 56 microfilaria larvæ in his drop of blood; a 7-year-old boy had 125; a 28-year-old man had 420; another, age 36 years, had 397; and one, 45 years of age, had 383. Among females the highest were 245 in a 12-year-old girl, and 150 in a 76-year-old woman.

One hundred fourteen (114) persons were found with enlargements of limbs and other parts of the body due evidently to filariasis. Very probably this number represented much less than those actually having clinical manifestations of the disease, particularly among women who are naturally reluctant to divulge symptoms in hidden parts. The data, nonetheless, are presented in tabular form below. The youngest with scrotal enlargement was a boy 11 years old; the oldest was a 90-year-old man. Of the males 30 or 30.84 per cent of the 109 with symptoms had their blood positive for microfilaria larvæ. One or 20 per cent of the five women with enlarged limbs had also her blood positive. Age-group 41 to 50 years among the men had the highest number having enlargements.

SUMMARY

1. The problem of controlling mosquitoes responsible for the transmission of filariasis in Sorsogon Province is presented.

2. *Culex fatigans* in Sorsogon Province has for the first time been found in nature with the infective third-stage microfilariæ.

3. *Culex fatigans* in areas of Sorsogon Province treated with DDT for three consecutive years, seems to have already developed resistance to this insecticide. For, in numerous instances this mosquito was caught while resting on walls and other parts of houses, where traces of DDT were readily visible. And those caught at such situations remained alive for two or more days in test tubes without food or water. More disturbing, indeed, was that several *fatigans* caught in DDT-treated houses had the infective third-stage microfilariæ.

4. Because *C. fatigans* is more closely associated with man in his habitations night and day, it seems very likely that this mosquito is responsible for more transmissions of filariasis than *Aedes poicilius*.

5. *Aedes poicilius*, on the other hand, would seem to be also difficult to control with insecticides. It is said to be a daytime

biter of man in abaca plantations. Moreover, it enters houses to feed rather late in the evening (about 8:00 to 9:00 p. m.) and leaves the premises before 6:00 a. m. Consequently, it seems possible that it does not get a fatal contact with DDT residuals indoors: Witness the two microfilaria-positive *poicilius* (one with infective microfilariæ) caught in houses well-sprayed with DDT.

6. Worth watching carefully, in addition, are *Culex fuscocephalus* and *Mansonia uniformis*, both of which showed very high infection rates in Sorsogon Province. None so far has been found with the infective microfilariæ. But in other parts of the Philippines these two species are frequently found in houses even during the day, and they seem now capable of surviving long contact with DDT residuals in houses. And *uniformis* is reputedly an efficient filaria transmitter in other countries.

7. Though 2 *Culex* (*tritaeniorhynchus*) *summorosus* caught in a carabao-baited trap were found with infective microfilariæ, this mosquito does not seem to be a serious problem owing to its very marked zoophilic biting habits.

8. Data pertinent to the 12,758 inhabitants (of all ages) examined for filaria infections in Sorsogon Province are presented. Tables are given to show (*a*) distribution of infections by sexes, by age groups, and by localities; (*b*) parasite-counts of different infected individuals; (*c*) distribution by age groups and sexes of enlargements of scrotum and limbs. Infections were found in all ages: from 3-year-old boys and girls through all ages to the oldest, 108-year-old man. Higher incidence and heavier infections were among males, and much more elephantiasis were seen in men than among women, although in this matter very probably a number of women did not divulge enlargments of hidden parts. The youngest with scrotal enlargement was a boy 11 years in age, and the oldest was a 90-year-old man.

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found the means to undertake the Filariasis Survey in Sorsogon Province. Second to them was the Filariasis Survey Party itself, which was splendidly headed by Dr. Melencio Santa Maria, Malariologist Supervisor of Southern Luzon and Bisayan regions. He was efficiently assissted by picked men of the Institute of Malariology: Messrs. Benjamin Gramata, Willie Velasco, Liberato del Rosario, Rodolfo Esguerra, Reynesto Lota, Ernesto Aldea, Reynaldo Sanchez, and Epifanio Bueno. Sent ahead of them to the place were Messrs. Felix V. Dantis and Jose G. Santos who made the preliminary observations on the incidence and habits of mosquitoes indoors in sprayed and unsprayed houses. They were later replaced by Messrs. Jacinto Regalado and Romeo Ugalde who continued catching and air-shipping living mosquitoes to Manila when the Filariasis Survey terminated. In no little way Dr. Winifredo Santos, Head Malariologist of the Southern Bicol Malaria Unit, helped the Survey Party. Subsequently he was appointed as head of the proposed Filaria Pilot Project.

In countless occasions, the very active young Governor of Sorsogon Province, Hon. Juan Frivaldo, the Provincial Health Officer, Dr. Juan Amanse, and his men, municipal officials, teachers, and others too many to ennumerate, facilitated the work of the Survey Party. To them and to everybody, the gratitude of the Survey Party is hereby expressed.

At the other end of the line—in the Institute of Malariology at Tala—Mrs. Adela U. Pagayon supervised the examination of the first batches of blood smears, and directed the entire work on dissections and examinations of mosquitoes for microfilaria worms. She is particularly to be commended for overcoming, in a relatively short time, the lack of experience in filaria work of those who assisted her, and of those who later came in for training in this work. Equally important was the efficient handling of the large bulk of blood smears that came later, by Miss Concepcion Felizardo and the group of highly trained assistants she had.

Abroad, Doctor J. A. Reid, Senior Entomologist of the Institute for Medical Research at Kuala Lumpur, Malaya, and Dr. T. Wilson, the Head of that Institute now (Dr. J. W. Field having just retired) very kindly and promptly re-examined for confirmation the positive blood smears and microfilaria larvæ from mosquitoes sent to them by us for verification. In order to further ascertain the species of microfilariæ in

man of Sorsogon Province, Doctor Wilson requested specially prepared, unstained thick blood films. He stained these by his particular method, examined them and sent back duplicates to the Philippine Institute of Malariology. Similarly, Doctor Reid sent mounted third stage microfilariæ from mosquitoes of Malaya. For these and for other matters (Doctor Reid has been a long-standing correspondent and consultant of the author), thanks and greetings to Dr. Reid and to Dr. Wilson.

REFERENCES

1. Baisas, F. E. Notes on Philippine Mosquitoes, XVIII. The Malaria Vector, flavirostris: Summary of Recent Findings. Submitted for publication to Monthly Bulletin, Department of Health, Manila. Sept. 14, 1956. MS. 25 pp. + 1 map.
2. Cabrera, B. D., and M. Tubangui. Studies on filariasis in the Philippines, III. Aedes (Finlaya) poicilius (Theo.). The mosquito intermediate host of Wuchereria bancrofti in the Bicol Region. Acta Medica Philippina. 7 (1951) 221–229.
3. Edeson, J. F. B., and R. H. Wharton. Filarial parasites resembling Wuchereria malayi in domestic and forest animals in Malaya. Trans. Roy. Soc. Trop. Med. Hyg. 49 (1955) 604–605.
4. Hodgkin, E. P. (1939), J. O. Poynton, and E. P. Hodgkin (1939) as cited by Edeson & Wharton (above, 1955).
5. Reid, J. A. Relation of Anopheles hyrcanus group to filariasis in the Anopheles hyrcanus group in Southeast Asia (Diptera. Culicidæ). Bull. Ent. Res. 44 (1953) 5–76.
6. Reid, J. A. Resistance to insecticides in the larvæ of *Culex fatigans* in Malaya. Bull. World Hlth. Org. 12 (1955) 705.
7. Reid, J. A. Field trials of larvicides for use against *Culex pipiens fatigans*, with a note on the life-cycle of this mosquito. Ann. Trop. Med. Parasit. 50 (1956) 129–136.
8. Reid, J. A. Personal Communications, dated May 18, 1956, August 3, 1956, and September 19, 1956.
9. Rozeboom, L. E. Final Report Concerning Exchange Professorship, Institute of Hygiene, University of the Philippines, for the Academic Year 1954–1955. Mimeographed copy (1955) 11 pages + 4 tables.
10. Rozeboom, L. E., and B. D. Cabrera. Filariasis in the Philippine Islands. Am. Jour. Hyg. 63 (1956) 140–149.
11. Wharton, R. H. The Behaviour and Mortality of Anopheles maculatus and Culex fatigans in Experimental Huts with DDT and BHC.
12. Wilson, T. Differences between the microfilariæ of Wuchereria malayi and Wuchereria bancrofti in geimsa-stained thick blood films. Trans. Roy. Soc. Trop. Med. Hyg. 50 (1956) 54–57.

THE TAMBALAN AND HIS MEDICAL PRACTICES IN LEYTE AND SAMAR ISLANDS, PHILIPPINES

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The *tambalan* (herb-doctor or medicine man) is, even in modern Philippine society, a respectable personality. In cities and towns with modern hospitals, the tambalan is still called by the upper-class Filipino in cases where modern medical practice seemingly fail. Among the lower-class people, particularly those found in barrios, the tambalan is more trusted than the district health inspector who regularly visits their places.

The reasons for this attitude are manifold. In folk-belief, the tambalan is believed to have supernatural powers to contact and control the spirits. A sickness caused by spirits, which cannot be cured by modern medicine, can only be cured by the tambalan; therefore he has, in the mind of the ordinary people, an edge over the modern doctor. His personal approach, compared to the cool professional attitude which often characterizes that of the doctor or health inspector, in applying his remedies and the long rituals involved in their application have a quieting and favorable effect on the patient.

The money question may be another reason for securing the services of the tambalan. Since it is believed that the healing power of the tambalan is a supernatural gift which might be lost if money is taken for his services, the medicine used by him is cheap and is often without charge. For a grave sickness, payment may be in kind, such as food and tuba which can be secured more easily than the cash that may be needed for an injection prescribed by a modern doctor. Thus for financial reason the poorer classes[1] are compelled to avail themselves of his services, although to the well-to-do this cannot be true, because of their willingness to spend more money for a banquet that the tambalan may require than for the cost of the necessary medicine that may be prescribed by a modern doctor. It is apparent, therefore, that the tambalan is trusted more than the modern doctor and even the well-to-do people are wont to avail themselves of his services.

[1] Even students prefer to go to the *tambalan* than to pay the cost of an injection for skin disease.

Origin of the tambalan.—The institution of the tambalan is older than recorded Philippine history. It may be simply explained thus: The origin of sickness in man may be traced to the days when he was driven out of paradise. Man needed attention and help. Some members of early society, being more intelligent than others and living close to nature, found the healing qualities of certain plants by experimenting with them. It was natural for them to help their suffering kinsfolk. Thus came the tambalan in whom the more credulous attributed special supernatural powers. Some tambalan more ambitious than the others capitalized on the people's credulity, as may still be seen today; while those who refused to take advantage of the credulous could not afford to brush aside easily the air of "mysticism" ascribed upon them.

This article does not attempt to trace the origin of the tambalan through local history, but records and describes the available information on the subject in the islands of Leyte and Samar.

Two beliefs are common as to how the tambalan derived his power.

The power is bestowed upon him by the spirits. In Abuyog, for example, it is believed that the "spirit of the mountains" or "cave spirits" open their caves during the Lenten season. If someone happens to enter such caves and finds a bottle in which a plant is growing naturally, that is with roots down and leaves up, he will become a good tambalan; but if he finds a bottle with an inverted plant he will automatically become an *aswang*.[2] A similar belief is held in case someone finds a *mutya* (magic stone), which even would make him a better tambalan. The mutya, placed in a bottle with water helps the tambalan to diagnose a sickness and to prescribe the cure for the ailment.[3]

One can also become a tambalan by seriously preparing and training for one. This is the belief and practice in Biliran Island. In the Naval-Almeria-Kawayan region of the island, north of Leyte, one intending to become a tambalan goes through a rigid initiation. He spends nine Fridays in the forest where he is attacked by all kinds of animals. This attack is said to be only in his dreams and in his imagination. The following nine Fridays he spends in the sea; the next nine

[2] Informant from Abuyog, Leyte.
[3] Informant from Tolosa, Leyte.

Fridays, in the Church; and the last nine Fridays, in the cemetery. After this ordeal the aspirant becomes a full-fledged tambalan and can cure all kinds of diseases.[4]

The tambalan in action.—To cure an ordinary sickness, the tambalan applies some herbs or uses only his saliva; therefore he is called "Dr. Laway." In case of a more serious sickness he makes a thorough diagnosis the practice of which varies among the practitioners.

The egg-ceremony is widely used in practice. In Biliran Island, the tambalan enters the sickroom with a round bottle and a fresh egg. After saying a few prayers and a blessing, he lays the bottle horizontally on a table and tries to make the egg stand on the bottle. If he succeeds, the tambalan tells the patients' relatives that fairies of *anitos* harmed the sick and that offerings have to be made to pacify the spirits.[5]

In Culaba, Biliran Island, the tambalan makes an egg stand on a plate. If the egg stands, the tambalan will say that the sickness is due to some spirits of their dead ancestors who are angry, because the family members have forgotten to pray for them. The tambalan tells the family to perform a *novena* in honor of their dead ancestors. On the last day of the novena, he tells them to give a feast and to prepare their favorite food. The spirits of their dead ancestors are invited to dine at the feast.[6]

In Samar, the tambalan uses a fresh egg, rolling it carefully over the skin of the sick person and showing the relatives the shadow of a tree in the egg which becomes transparent. He explains that this tree is inhabited by spirits which have been offended by the sick and should therefore be appeased by offerings.[7]

A Bohol informant[8] gave this interesting account: "My grandfather was paralyzed. Several weeks of treatment in the provincial hospital did not bring him any improvement; he could not move. So my father brought grandfather to a famous tambalan. The tambalan used a fresh egg, oiled it and rolled the egg over the skin of my grandfather where pain was felt. As he did this, he uttered word which sounded like Latin. Afterwards the tambalan broke the egg

[4] Informants from Kawayan and Naval, Leyte.
[5] Informant from Biliran, Leyte.
[6] Informant from Culaba, Biliran Island.
[7] Informant from Basey, Samar.
[8] Informant from Tagbilaran, Bohol, an island southwest of Leyte.

and placed it in a plate. All of us could see what was inside the egg. We saw small bones of a fish, small sticks and a tiny stone. My grandfather could then move his hands and his feet. The tambalan told us that my grandfather was harmed by another person out of envy and hatred. Twice or thrice a month the tambalan visited my grandfather and treated him with an egg, till he could walk. Everytime he rolled the egg, we always found things in the egg which were peculiar."

The *mutya* stone is also helpful in the diagnosis of such sickness as mentioned above.[9] The same Bohol informant reported the use of a crystal stone for diagnosis: "While we were still living in Bohol, my parents called a tambalan in time of sickness. He claimed he could tell an ailment by means of the reflection of a small crystal stone which he found while taking a bath in a river. This stone appeared extraordinary and was different from other stones I knew. With this stone he ascertained each sickness and prescribed the kind of herbs to cure it. This particular tambalan often relieved my mother and my father of some of their pains."[10]

Besides the use of fresh eggs, crystal gazing and *mutya* stones, the tambalan identifies sickness by feeling the pulse, the forehead, and the temple. In Basey, he uses sometimes a cane to identify a disease, besides using the said cane to heal the same disease. The tambalan points the lower end of the cane to the sick part of the patient. He then whispers strange words at the top of the cane. These words are supposed to have a healing effect.[11]

The patient is also questioned in detail about the places he visited last, in order to determine the origin of his sickness. This often reveals that some invisible beings "have injured" the patient. The objects "found' in the broken egg are believed to be the instruments with which the invisible beings have injured him.

One might distinguish between magical and empirical treatment by the tambalan.

Magical treatment.—If the tambalan identifies the sickness as having been caused by an offended spirit, the treatment is to appease the spirit. One can offend a spirit even unknow-

[9] Informant from Tolosa, Leyte.
[10] Same informant from Tagbilaran, Bohol.
[11] Informant from Basey, Samar.

ingly. If someone, for example, happens to enter a territory where the *umurukoy* (spirits) are living, mostly in trees or bamboogroves, to cut or damage a tree or to make a *kaingin*[12] without informing the spirits may cause the spirits to get angry and harm the offender.

The offering or appeasing ceremony is, in the main, the same all over Leyte and Samar. The tambalan asks for a big chicken which must be either all white or black. This is cooked without salt and offered together with other food such as cooked rice, cakes, and drinks. Cigars and cigarettes are also offered. The ceremony is usually performed in the early morning or late afternoon.[13]

The procedures and materials offered vary depending upon the locality where found or on the tambalan making the offering. In La Paz, Leyte, for example, the things used by the tambalan are: 7 small bamboo tubes about 4 inches long containing *tuba;* a bottle of alcoholic drink (like Blue Label); 7 plates of biscuits—three biscuits on each plate; 7 eggs; 3 fat hens and the like.[14]

Around 6:30 o'clock in the evening, the tambalan goes with his materials to the place where the sick person was supposedly injured by the spirits (*encantados, umurukoy,* etc). No one is allowed to go with him.[15] There he makes the offering to the spirits and prays for the recovery of the victim. The prayer is one of his secrets. After the offering, he brings all the materials back to the house of the sick where he and the patient's relatives partake of them at a banquet.[16] In other places,[17] the food is left at the place of offering and is not taken home.

Empirical treatment.—The distinction between magical and empirical treatment is more or less purely theoretical. Most tambalan combine both treatments in their practice. Nevertheless, the distinction serves its purpose in this study.

[12] *Kaingin* cultivation is shifting agriculture and means abandoning old and clearing new fields every one in four years.

[13] Informant from Palo, Leyte.

[14] Informant from La Paz, Leyte. This ceremony is called *panagay* from *tagay,* meaning "to pour." The person who is an expert in *panagay* is known as *mananagay.*

[15] So in La Paz, Leyte, but in Palo, Leyte, and other places the *tambalan* may take along other people.

[16] La Paz, Leyte.

[17] Palo, Leyte, for instance.

The use of herbs in the treatment of sickness is as old as history and is known to the primitive as well as the highly civilized people. This is so in the Philippines. In Leyte and Samar the following practice was observed: if the patient has fever the tambalan uses the plants, *ganda*, *panhaole*, *hierva buena*, *hawas*, *hierva maria*, and camangyan mixed with *pili* sap. The plants are pressed and squeezed in order to extract their juices, resulting in a bitter liquid, reddish in color, with a foul odor. Before the patient drinks the liquid a short prayer is said to bless the drink. After partaking of the liquid, the tambalan applies a portion of it on the forehead, on the joints of the hands and feet of the patient. Thereafter, the herbs from which the juices have been extracted are wrapped in cloth and placed on the forehead, in case the patient suffers from fever. Should he suffer from asthma the same compound is placed on the chest or the back.[18]

A patient with a boil or a swollen part on the body is treated as follows:[19] the tambalan applies his *laway* (saliva) on the swollen part. He goes to the kitchen where he spits a part of his saliva on a stove, offering a short prayer. He asks for a glass of water and places leaves, grass, roots and the bark of trees in it. He tastes this mixture, says a prayer and gives it to the patient to drink. While sick, the patient is not permitted to drink any water except the above mixture. As soon as the boil bursts open and pus flows out, the tambalan prepares an ointment made of the ashes of burnt *hierva buena* and burnt *Cochoachis* mixed with coconut oil. This mixture, called *lanta*, is applied along the edges of the wound. It is the tambalan's belief that if lanta is applied directly on the boil's opening, the opening will close on top without healing the boil.[20]

In Eastern Leyte, a headache is treated as follows: the thick leaves of the plant, called *siempreviva* [*Bryophyllum pinatum* (Lam.) Kurz.], are slightly bruised by pressing with a bottle. The bruised leaves are then placed on the patient's temples.

The leaves of a certain kind of orange plant are rubbed together until crumpled. They are then applied on the forehead, covering them with a piece of cloth long enough to be

[18] In Gamay, Samar.
[19] *Ibid.*
[20] Informant from Gamay, Samar.

tied around the head. The leaves of the *lakdan* tree are used in the same way for headaches. In other parts of Eastern Leyte, the *lakdan* leaves are used for stomach troubles and delayed menstruation.

For stomachache and diarrhea in Eastern Leyte, *tuba* leaves are boiled in water and the liquid is drunk. Tobacco leaves are also used. The leaves are placed over live charcoals, after which they are dried and shredded and mixed with saliva. This mixture is placed on the stomach. The roots of the ruda plant serve also as a remedy against stomachache. The roots are boiled in water and the liquid is drunk while warm.[21]

In healing an eczema in Eastern Leyte, different herbs are placed in a pot with water, then covered with *payao* (*Homalomena Philippinensis* Engl.) leaves and boiled. When the water is boiling a hole is made in the center of the cover. The part of the body with eczema is then placed over the hole allowing the said part to be exposed to the steam.

To effect easy delivery of a child, an orange is divided into halves and placed over live charcoals. Then both halves are squeezed while still hot and the juice is rubbed on the stomach of the woman about to give birth.[22]

The herbs mentioned above are also ordinarily used by barrio people for self-cure of fevers, headaches, asthma, boils, and stomachaches. In using the same herbs, the tambalan invariably adds his famous *oracion* (prayer). In Gamay, Samar, before the treatment he first asks permission from the spirits by going to them in the forest where, according to folk belief, they appear to him only. If the spirit appears to him, he starts with the treatment, but if they fail, he waits for the next day until they appear and he is permitted by them to start treatment.

Some of the herbs the tambalan uses are gathered by him on Good Friday. On this day, he goes to the mountains and gathers the herbs in caves. In a secluded place in the mountains he prepares also from a selected coconut the magical oil he uses in his treatment. At midnight of Good Friday he goes to church and then to the cemetery.[23]

The *lo-on* (fumigation) is a well-known method of treating sickness caused by "fear." It is known all over Leyte and

[21] Informant from Tacloban, Leyte.

[22] *Ibid.*

[23] An act called *turumanon* (a sort of commitment or promise, according to an informant from Culaba, Biliran Island).

Samar and is an interesting combination of magical and empirical practices. In this as well as in other treatments, the tambalan uses bad smelling herbs to discomfort the spirit and to make them vacate the body of their victim.

A "classical" type of a tambalan performance.—The practices so far described are more or less common all over the islands of Leyte and Samar. While strongly animistic in motifs, the practices show more and more Christian elements, and most of the tambalans, including those making use of them, regard themselves as good Catholics.

It is interesting to note that in regions that have partly broken away from Catholicism and have been deeply influenced by other religions, the tambalan has a stronger hold on the people and his practices show a return to earlier pagan animistic rituals, and is hostile to the Catholic Church. This impression was gathered in the spring of 1956, when the writer visited the Kawayan-Almeria region in Biliran Island, which is deeply imbued with Aglipayanism and Seventh Day Adventists.

The practices of the tambalan in this region are unique and show a reversion to pagan origins. In the sitio Tubigguinoo of Kawayan, the tambalan practices first the *pa-apong* [24] (to let the spirit come) ceremony. A family with an ailing member will gather around the patient in the living room. Four tambalans are called. The tambalan who is supposedly possessed of a stronger will, heads the group to contact the spirits. When he has contacted the spirits he welcomes them, while his three companions keep quiet for an hour in reverence to the presence of the spirits. Thereafter the head tambalan converses with the spirits to find out the kind of sickness the patient has. The assistant tambalan interprets the result of the conversation and announces to the audience the kind of illness of the patient as communicated by the spirit. Thereafter the head tambalan tells those present what the spirits ask for. Usually these things are:

A chicken with red feathers and black legs;
A black pig with white feet;
Additional chickens—all white for the invited spirits;
Seven glasses of wine;
Seven glasses of *tuba*;
Seven pieces of biscuits;
Seven pieces of cigarettes;

[24] Term in Cebuan dialect.

Seven pieces of rolled tobacco;
One dozen eggs, and *tilad*[25] composed of lime, buyo leaves, tobacco, and betel nut.

After announcing the above, the tambalan makes a loud sigh or a moan as an expression of thanks to the spirits.

Following the pa-apong, seven days are allowed to secure the gifts intended for the spirits. After this period the *pana-ad* (performing the promise) is carried out. This is preferably done during a full-moon. At about seven o'clock in the evening, after cleaning the yard, tables are arranged in banquet form and loaded with the gifts intended for the spirits. The four tambalans, dancers, visitors and the patient with all the members of his family attend the ceremony.

Each tambalan has his assignment. The chief tambalan serves as spokesman and talks with the spirit. One assistant tambalan serves as interpreter, the third acts as entertainer of spirits present only as visitors, and the fourth attends to the patient. A big fire is built in the courtyard. Musical instruments made out of bamboo and a rusty piece of iron for making sound are brought out. Suddenly the chief tambalan yells loudly, calling the spirits to come. Five minutes later he covers his head with a red handkerchief and starts to dance, symbolizing the appearance of the chief spirit who precedes all other visiting spirits. All persons present bow their heads, close their eyes moving their lips silently in reverence, loyalty and homage to them.

Thereafter women with a red handkerchief around their heads dance around the fire. The men dance a kind of *tinikling* dance. Another part of the ceremony is the saucer dance of the assistant tambalan (interpreter). He dances with a saucer placed on top of one of his fingernails. While the interpreter is dancing, the saucer turns rapidly on the fingernail. In the end there is a community singing of a very sad and sentimental song.

The healing process.—When the community singing has ended, the patient is laid on a table. The assistant tambalan holds in his hands a sharp bolo. As the chief tambalan works himself into a trance and the patient is in a similar condition, it is believed that both are "magnified" by the spirit. Suddenly the chief tambalan commands the assitant tambalan to stab the patient. The interpreter stabs the patient with the bolo.

[25] A preparation for chewing which can be bought ready-made in markets for five centavos. Gifts vary depending on the kind of sickness treated.

Everyone present is obliged to keep quiet. The people believe that the patient will be wounded if someone talks. Meanwhile the chief tambalan goes seven times around the patient mumbling words supposed to be dictated by the spirit who has "entered" the tambalan. He then blesses the patient. At the end of the ceremony, all eat. Seven days thereafter the patient receives his first bath. On this occasion another banquet is prepared by way of thanking the spirit who, according to the people's belief, was responsible for curing the patient.[26]

The unique healing practice in the Kawayan-Almeria region in Biliran Island, Leyte, comes most probably closest to an old pagan practice. In this region the tambalan practice in groups, whereas in other parts of Leyte they practice individually. Where the influence of the Catholic Church is at its least here, Aglipayans[27] and Seventh Day Adventists have made deep inroads, especially in the barrios. The tambalans have been most unfriendly towards the Church here, as historically shown by the Bankao revolt of 1622, which was actually aimed against the Catholic Church.[28]

The rural people believe that the healing power of the tambalan is only one of his attributes. They believe that he can also control the spirits of the fields and the forests and can even check the influence of the *aswangs* and cure those who are in the first stage of being bewitched.[29]

[26] Informant from Kawayan, Leyte.

[27] Local term for followers of the Philippine Independent Church sect, after its founder, Gregorio Aglipay.

[28] The writer had the opportunity to interview one of the tambalans in Almeria, Leyte, who was the focal point of resistance against the Catholics. After a warm-up period the tambalan showed a notebook which he kept under lock deep in a drawer. He showed several pages of scribbling-like code signs. He insisted that the spirits were communicating with him in this way everyday. No one had access to the drawer, but every morning a new page was written by the spirits. The writer had no time and means to test the truth of his statement.

[29] For a detailed report of the tambalan and witchcraft, see: Richard Arens. Witches and Witchcraft in Leyte and Samar. Philip. Jour. Sci. 86 (1956). For the ability of the tambalan to control the spirits of forests and fields, see: Richard Arens. Animism in the Rice Ritual of Leyte and Samar. Philip, Sociol. Rev. (January, 1956).

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